ENGLISH AND AMERICAN

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—BY—

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WITH DISCUSSION

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By EDWARD BATES DORSEY, M. Am. Soc. C. E.

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Perhaps the first thing that strikes an American engineer in railroad traveling in England * is the inconvenience of the English * passenger car. It should, however, be considered that this style of car suits the exclusive and retiring character of the English; and also that very long journeys, such as we are accustomed to make, are impossible in such a small island; moreover, the English do not travel nearly as much as we do, consequently the confinement in a small, locked-up

* EXPLANATORY NOTE.—In this paper, unless otherwise stated,

The words England or English will represent the United Kingdom, *i. e.*, England, Scotland, Wales and Ireland.

The pound sterling will be considered equal to five dollars American money.

The American ton contains 2 000 pounds.

The English ton contains 2 240 pounds.

The data used in this paper relating to the English railroads, were taken from the reports of the Board of Trade of the United Kingdom, or from the reports of the different railroad companies.

The data relating to the American railroads were taken from the reports of the Railroad Commissioners of the different States, Poor's Manual, and the reports of the different railroad companies.

For some unexplained reason, these different authorities do not always agree, consequently there may be apparent errors in this paper, when comparison is made with authority different from that from which it was originally taken.

compartment is not so much felt as it would be with us in our long journeys.

Much allowance must be made for the modern English railway engineer. Whatever faults he may have seen in the passenger cars, he has been powerless to make any important change, except at an unjustifiable cost. Stephenson and his colleagues mounted the old stage-coach body on car wheels, which became the type of the passenger cars; and coal wagons that were then in use in the collieries were put on the railroad, and became the type of freight cars; and before the conservative English character thought that they ought to be improved, and should be changed, the trunk lines had been built, adapted to this narrow and low type of rolling stock; to have made it wider and higher later would have required the removing and reconstruction of the masonry platforms, the raising and widening of bridges and tunnels—in fact, almost a reconstruction of the road. This will prevent the use of our high, wide and pleasant cars. It is not fair to blame the modern English engineer for continuing the use of this description of cars, which he cannot change at any justifiable expense.

Owing to the extent of the United States and the apparent isolation of our early railroads, or separation from each other (at the beginning we did not think as much of continuous connections, and not breaking bulk as we do now), our engineers were comparatively free to invent and adopt the best system according to their judgment, and later, when it became necessary to consolidate, the fittest has survived in our present system. Perhaps, owing to our bad roads, the American stage-coach did not come up to the American engineer's idea of luxurious or comfortable traveling; hence he kept on improving, and developed the Pullman hotel train as run between New York and St. Louis or Chicago. while on the good English roads this stage-coach came up to Stephenson's ideas of comfort and luxury.

Engineering, Locating, etc.

It is evident that the English engineer was not obliged to study economy so closely as the American in locating or constructing; judging by the work, the former has always had at his disposal abundance of time and money. The roads built by him could not have been built, as some of our American roads have been, at the rate of over five miles per day; or, as some were done, by laying the rails first and afterwards

building the road. The English engineer seems to have the idea that the railroad should be built as near a straight line and level as possible, and is willing to spend a much larger amount to approach this ideal perfection than the American engineer is. Consequently the English railroad is located much straighter, with easier curves and grades than the American location would have been over the same ground, but at greatly increased cost in money and time required for construction. Recently English engineers have introduced on their new roads curves and grades that would have been considered impracticable by Stephenson and his contemporaries.

In locating railroads in England, the engineer derives much assistance from the maps of the Ordnance Survey, which are so perfect that the route and approximate location can be determined before going on the ground in all the counties; while some counties are so perfectly contoured that a location and profile could be made without a survey, which would be correct enough for preliminary purposes.

Special Acts of Parliament must be obtained for every new road or branch. Before this can be applied for, much less obtained, there must be a very exact profile and map filed, showing everything within three hundred and thirty feet on each side of the proposed line. If Parliament should grant the application, only a very small deviation in grade or alignment is allowed from the plan and profile filed originally. These plans must be very correct. There is a story told that an application, strongly backed, was thrown out because a pig-sty had been omitted on the map filed. This application before Parliament is generally bitterly opposed by rival roads and interests, and the fight becomes long and expensive, each side employing prominent engineers and lawyers. It is said that in a recent case before Parliament, a prominent American engineer received 2 000 guineas ($10 500) for his testimony, which he gave in two and a half hours.

The following table shows the money that has been expended in promoting or opposing Bills before Parliament for eleven years, from 1871 to 1882 inclusive:

Municipal bodies	£1 289 757
Railway, Gas and Water Companies	4 664 874
Canal and Tramway Companies	416 043
Harbor and Dock Companies	360 574
Total	£6 731 248
At $5 per pound sterling	$33 656 240

About \$3 000 000 annually, and this in dull times, after all the principal improvements had been completed or commenced. This amount is admitted to have been paid; probably much more was paid and charged to other accounts. Of this amount, £380 160 went in "House fees" paid to the House of Commons; say the fees paid to the House of Lords would be as much, there still remains £6 000 000 admitted to have been paid. This parliamentary business is very good for the English engineers; probably many of them make as much, or more, engineering in the Houses of Parliament as they do in the field. As a proof of the importance of this parliamentary engineering to the profession, nearly all the prominent engineers have their offices in Westminster, near the Houses of Parliament, and not in the city near the money center as with us.

The right of way is easily and quickly obtained after Parliament grants the right to build the road. In this grant is inserted what is called "Clauses Consolidation Acts." This provides that, in case the necessary land cannot be obtained on satisfactory terms by private purchase, application may be made to certain judges or magistrates named, who order the land in dispute to be appraised and the amount of this appraisement to be deposited in the Bank of England. As soon as proof is produced of this deposit, possession is given of the land. The money deposited is held, subject to the final settlement, by the Courts or otherwise, of the money to be paid for the land.

England offers no very serious engineering difficulties against railroad construction. But few lines attain the elevation of 900 feet above the sea; they have no high backbone divides to be crossed as we have. Probably the whole of England will compare in this respect with the United States, after excluding the strictly Prairie States. In round numbers, half of our railroads are constructed in a country offering no greater advantage than the United Kingdom for cheap construction.

English railroad men—it may be said foreigners generally—have a very erroneous idea about the physical geography of the United States. Nearly all believe that the American roads are built at a comparatively small cost, because the whole country is a level prairie, with nothing to do but to lay the ties and rails on the prairie sod. An old officer in the railroad department of the English Board of Trade was very much astonished when he was told that all our American roads are not built on the level prairie.

Cost of Land and Right of Way.

This is a large item in the cost of most English railroads. It is impossible to say how much, as no reliable data could be obtained. Some say it will average twenty thousand dollars per mile; this is undoubtedly too high. Cases have been mentioned where the price paid has been so large, that in our plain American language it would be called blackmail, but in the more polite English it is called land damages.

Construction.

This is generally much superior, stronger, more substantial, and a great deal more costly on the English roads than on ours. This difference is much greater on new roads. Our system of rushing the road through, and completing it afterwards at leisure times, is not practiced there. The Board of Trade impartially obliges every road, large or small, to be made at first up to its standard of perfection; consequently all English roads are well made at first, and kept up—all are first-class; if one falls below the standard, it is closed. This would be rather hard on some of our roads.

Wooden culverts or trestle-work are unknown in England. Brick viaducts are generally used where we would use trestle-work, or embankments in shallow depressions. Bridges are almost always built of brick, stone or iron; wooden ones are very rare.

Platforms and stations are generally built of masonry; some few are built of wood.

Embankments in England are generally made flatter, or with more slope than ours. Cuts are generally allowed to take their natural slope, though much more attention is paid in England to foot and side drains than with us.

The ballast in England is generally sandy gravel; there is no such road-bed as that on the Pennsylvania or Reading Railroad. The ties are sawn, generally over 10 inches wide, 6 inches thick and 9 feet long, and placed about 34 inches from center to center; at joints they are somewhat closer.

The rails generally used are the double-headed or reversible pattern, running up to 87 pounds per yard, with 52-pound chairs, on some of the railways running into London. The rails are secured into the chairs by wooden wedges or blocks. Some few flat or flanged bottom, called Vignolles or Colonial rails, are used, but they do not seem to be popular, Rails are generally 30 feet long, and made of Bessemer steel.

The English engineer is much favored by his mild winters. The frost is not sufficiently severe or penetrating to affect the stability of his road-bed or superstructure. The snows are comparatively very light, and would give no trouble, provided the railroad had the most simple ploughs in use on our Northern railroads for removing it.

In England there are no street, and very few ordinary road-crossings on a level, and these few are always provided with a gate and watchmen. The Board of Trade is very stringent in this respect, and we should imitate them by passing a law obliging all railroads in populous districts to do the same.

The ties are buried deep, apparently to make the road-bed as solid as possible, and on the end of the ties the ballast is heaped up to the level of the top of the rails. On some roads the chairs are bolted to the ties by screw-bolts, with the nuts under the tie.

As a sample of how costly the English railroads are built, the author contemplated building a new station, and got from the superintendent of the railroad the cost of building it, which was $11 000. There was no grading necessary, all that was required was simply two platforms with shed roofs, connected by an overhead bridge, 14½ feet headway, with two stairways leading from the platforms to the bridge.

Mr. Webb, the able Locomotive Superintendent of the London and North Western Railway, has recently introduced a steel sleeper that gives great satisfaction and promise. It is 9 feet long, weighing 124 pounds; near each end the sleeper is punched with six holes for the chairs. The chairs, weighing 14 pounds, are rolled from the waste ends of the steel rails, etc., then stamped into shape and holes punched. A steel lining plate, ¼ inch wide, is placed between the chair and sleeper. To prevent noise and working loose, brown paper, soaked in tar, is placed between the chair and plate, and plate and sleeper; then the whole is riveted together with steel rivets. This makes a very firm and solid road-bed, without any possibility of the rails spreading. The total weight of the sleeper, chairs and plates complete is 174 pounds, and at the present price of steel should not cost in the United States over 1½ cents per pound, or $2.61 for each sleeper. Mr. Webb says the total cost of labor on this sleeper is 5½d. = 11 cents. Total cost of sleeper at present prices in England, 8s. 3d., say $2.00. The rails are fastened, or rather secured, into the chairs by wooden wedges, as is usual on the English roads. The life of this sleeper is as yet an unknown quantity; rust is probably

the only thing that will destroy it. If the constant jar would not break or detach the asphalt coating used so successfully on water-pipes in California; or the coating of Dr. Angus Smith, used in many places satisfactorily on water-pipes; provided either of these coatings could be kept on intact, the life would be very long and there would be no doubt as to the economy of adopting it. The London and North Western Railway have put down five miles of these ties in order to test them thoroughly.

Some of these have been in use for five years, and as yet show no signs of weakness or decay. The coating still remains intact, notwithstanding the five years' service, with the frequent jar of heavy passing trains. Mr. Webb anticipates no trouble from rust. He has taken up water-pipes in good condition that have been buried for sixteen years, which were coated, previously to being buried, by the coating of Dr. Angus Smith. Mr. Webb's sleeper or tie will probably come into general use, as it possesses the maximum strength with the minimum weight and cost.

Locomotives.

For fast passenger trains, the engine generally has two large drivers about 7 feet 8 inches diameter; outside connected cylinders, horizontal; with bogie truck in front, and two trailing wheels. For slower passenger and freight trains generally four drivers; inside cylinders, outside connected; some with bogie trucks. Some freight engines have six drivers, outside connected, with inside inclined cylinders; all weight of engine on drivers. Many new engines are now built with four driving wheels; outside cylinders and connections; cylinders generally inclined.

The cab has finally been introduced upon most of the English engines, though there are still many without it. But it is not such luxurious quarters as the American engine-driver has; it is simply a small iron hood with small and fixed glass bull's-eyes, or windows that cannot be opened as with us, consequently they are very warm, and many of the engine-drivers object to the cab for that reason. It seems strange that no one has thought of our plan of having the windows large and on hinges, to be opened or closed at pleasure.

The bogie truck and outside connections, avoiding the crank axle, have had a hard and severe fight for favor on the English locomotive, but finally their merit has been recognized and many of the new locomotives are built on this system. Chairman Moon, at the half-yearly meeting of the London and North Western Railway Company, August,

1884, said: "Nothing has pleased me more lately than to see the old-fashioned crank axle done away with. Wo have had no accidents with it, but we are going to have something better than the crank axle."

It may not be amiss to state that on the Continent, engines with inside cylinders and connections have been almost entirely superseded by those with outside cylinders and connections.

CONSUMPTION OF FUEL.

Many limited tests and experiments have been reported, but all, in my judgment, give much too high efficiency for the locomotive as a power producer, except on a limited experimental scale. Mr. William Strudley, M. Inst. C. E., Locomotive Superintendent of the London, Brighton and South Coast Railway, recently read a paper before the Institution of Civil Engineers. He stated that, in a locomotive of his design, one pound of coal will evaporate 12.95 pounds of water, and will convey one ton of train-load 13¼ miles at an average speed of 43.38 miles, the rate of consumption being 2.03 pounds of coal per horse-power per hour. The French engineers have reported recently 2.48 to 3.01 pounds of coal per horse-power per hour. In my judgment all these estimates are entirely too favorable; if not, the locomotive is not as expensive a fuel-burner as is generally thought.

Soft coal is universally used, except on the railroads in London, where a semi-anthracite is burned. This is used on account of giving off very little smoke, which would be very objectionable in the city.

PASSENGER CARS.

The extreme width of a passenger car that can be run on the average four feet eight and a half-inch gauge English railroad, is 8 feet 10 inches from extremity to extremity of eaves; this makes the cars too narrow to adopt the American construction of central aisle with double seats on each side. If it should be desired to adopt this system of central aisle, it would be necessary to reduce the length of the seats on one side from the length for two persons to that for one, as in some of our 3-feet gauge cars.

The Pullman cars that are run in England have been reduced in width from 10 feet to 8 feet 10 inches from eaves to eaves, and in height 13 inches. They are constructed on the same plan as generally with us, with a central aisle; the seats are too short to seat two persons

comfortably. They resemble very closely the Pullman cars made for our 3-feet gauge railroads.

For a short distance, and until the close confinement becomes tedious, nothing can be more comfortable and luxurious than the first-class English cars in pleasant weather. The absence of all toilet conveniences is a great inconvenience on long journeys.

On most railroads in England there is still no way of communicating between passenger, conductor and engine-driver, or from one car to another while the train is running. The London, Chatham and Dover road uses a bell-rope passing along the top of the floor, and the Great Eastern uses the bell-rope passing along the outside of the cars just under the eaves; this can easily be reached by opening the car window and reaching up.

The English passenger car is cold in cold weather, and hot and close in warm weather. If one is seated facing the engine he is in a gale, if seated on the front seat, is in a corner where no air can reach him. It does not run as smooth as the American; it is more difficult to read, and impossible to write in them.

On the London and North Western Railway, passenger trains with a seating capacity for 95 first-class, 60 second-class and 150 third-class—total, 305 passengers—and vans for their baggage, weigh 151.8 tons, or half a ton for each passenger.

Freight Cars and Trains.

The English freight car is about 15.5 feet long, with four wheels. About 90 per cent. of them are open cars, with sides and ends about 3 feet high. About one-fourth of each side at the middle of the car is on hinges, so as to open and facilitate unloading. About one-tenth of the cars are covered, corresponding to our box cars; these are generally covered with tarpaulins tied on; the roofs seem to be used more for safety or protection against robbery than for protection against rain. The open cars are always covered by a tarpaulin tied on, except when loaded with coal or other load that cannot be injured by the weather. These cars are coupled by heavy chains, and each car has about 1 foot of slack, consequently in starting the load comes very slowly upon the engine.

Only about 20 per cent. of the cars have brakes, and these are so placed that they cannot be manipulated while the train is in motion. In the rear of the train is a caboose with a brake; this, with those on the

engine and tender, is the only braking force that can be applied while the train is in motion. In long trains, or on steep grades, additional brake vans are attached, which make, on some roads, quite an important additional expense in the salary of the brakemen, and hauling up grade the dead weight of the brake vans, which, in order to be effective, are made very heavy.

These trains run generally about 25 miles an hour. The only hands employed on them are the engineer (called there the driver) and fireman on the engine, and the conductor in the tail caboose, with no means of communication with each other except by signs—the useful bell-rope not being used. One would think it would be impossible to avoid many serious accidents for the want of this communication between the conductor and the engine-driver, but they seem very fortunate in avoiding them. There is not much danger of a train breaking in two.

The average English freight car, or, as called in England, "goods wagon," carries a load of 8 tons, and weighs 5 tons, being 1.6 to 1; while with the American box freight car, carrying 50 000 pounds, and weighing 23 000 pounds, the proportion is 2.13 to 1.

Without any positive data before him, the author would judge that the first cost for the same amount of carrying tonnage is about the same in the two countries, but the cost of maintenance is probably in favor of the American car, as for the same carrying tonnage there are fewer pieces to be looked after and kept in order.

All freight cars are made of wood. Self-dumping or unloading cars are not in general use. Coal is generally unloaded by being shoveled into a wheelbarrow and wheeled to the pile; in some large yards it is unloaded by shovels, falling by gravity to the pile; in others, through a trap-door in the bottom of the car.

The English freight trains run at much greater speed than those of the United States, probably about 25 miles per hour. They do not average one-half of tons freight that the American trains do, while, owing to the superior construction of the roads, the comparatively straight lines and easy grades, the average train tonnage should be much larger —if not double.

The railway companies complain that the shippers require prompt delivery of goods. This could probably be done by the proper development of the express system, as practiced by the different railroads in the United States. This assures prompt delivery of fast freight, while

the slow freight comes at a much slower and profitable rate of speed to the railroad companies. By the reduction of the speed of the freight trains and increasing their load on the railroads of the United Kingdom, the cost of transportation could probably be largely reduced.

Passenger Fares.

The Midland Railway, which penetrates very thoroughly the Midland Counties of England and Southern Counties of Scotland, several years ago dispensed with the second-class carriages, and adopted the following rates:

First-class, per mile 1½d., and 5 per cent. Government tax added = 3½ cents. Third-class, per mile 1d. = 2 cents.

During the year 1883 the returns of the Midland Railway show that 94 per cent. of the total passenger traffic was third-class, which yielded 90 per cent. of the gross passenger receipts. Railways that have been brought into direct competition with it have been obliged to adopt the same rates, making their second-class fares about 2¾ cents per mile.

Where there is no competition, the following may be considered the average rates:

	Average per Mile.
First-class	4½ to 5 cents.
Second-class	3 to 3½ "
Third-class	2 "

The Great Northern Railway, one of the leading railroads of England, has recently decided to imitate the Midland, and only run first and third-class carriages on some of their lines. It is only a matter of time when all other roads will do the same.

It is only a matter of time when railways will dispense with or modify the first-class travel so as to make it pay; it is safe to say that no road in England now makes any money from its first-class travel. As long as they continue to sell first-class tickets, they must provide first-class carriages, as it is impossible to say beforehand what the transient travel will be; the consequence is, nearly every train has a large excess of empty first-class carriages, in order to accommodate all travel that may offer, as no one holding a first-class ticket would consent to take a seat in a second or third-class carriage. Moreover, the first-class passengers, even if the carriage were always filled, do not pay the road as well as the second or third-class. A compartment in a first-class carriage contains about 48 square feet, measured from

the outside of the car to the center of the dividing partition, and will seat eight persons. This gives 6 square feet to each person, which, at the price charged by the Midland Railway per mile, makes 6 divided by 3½, say half of 1 cent per mile for each square foot of the floor of the car. The second and third-class apartments contain 40 and 35 square feet, and will carry 10 passengers. Taking the average second and third-class fares, this will give about two-thirds of 1 cent per mile for each square foot of floor surface. The dead load being about in the same proportion as the floor surface, it is clear that the first-class passenger is the most unproductive; moreover, the first cost of the first-class compartment and its maintenance is probably 20 per cent. greater than the second-class compartment, and 40 per cent. greater than the third-class.

All roads in the United Kingdom, except the Midland, virtually run six classes of carriages, viz., ordinary and smoking first-class, ordinary and smoking second-class, ordinary and smoking third-class. As it is impossible to fill all of these uniformly, there must necessarily be great loss of room and unnecessary haulage of dead weight.

The railroads running into London run what are called workmen's trains; by these trains working men or working women can go to and from their homes and work (say up to 15 miles) for 24 cents a week; this allows them to live in the suburbs where it is more healthy and rents are cheaper; weekly tickets are sold for the above amount, good for special designated trains in the morning and evening. Our roads should imitate the English roads in this respect.

Brakes.

In passenger trains there is generally one car in every three or four that have brakes. The vacuum brake, after a long and hard fight, has gained the victory, and is coming into general use on passenger cars. On very steep grades, when the brakes on the engine and the few brake cars would not be sufficient to hold the train in case of accident to the air brake, platform cars heavily loaded with cast-iron, with powerful brakes, are attached to each train going up or down, in order to hold the train in case of accident to the vacuum brakes; an expensive inheritance from the narrow stage-coach model, which could be avoided if the brakemen could go through a central aisle from car to car, and apply the brakes on each car as with us.

The freight trains have no brakes that can be used while the train is in motion, except those on the engine and caboose.

Our system of brakes could not be applied to freight trains there, as, owing to the lowness of the tunnels and bridges—another expensive inheritance from the old stage-coach model—brakemen could not walk over and along the top of the cars, and apply the brakes as with us. The only brake that could be adopted with safety would be one that could be worked from the engine or caboose, or buffer or compression brakes.

Block System.

It is astonishing to see the blind faith the English engine-driver places in his block signals. In dense fogs, where he cannot see one hundred feet ahead, or dark nights, when his vision is also very limited, for his head light is only an ordinary lantern, useless for illuminating the track and only used as a signal, the same as the tail light, or frequently where he has both the dark night and dense fog to run through, yet he runs at full speed and generally on schedule time, feeling sure that he is perfectly safe because his block signals have told him so, and they cannot make a mistake or lie.

The underground railroad in London and the London suburban railroads afford a fine illustration of this system. Notwithstanding the proverbial London fogs, these roads run their trains, probably several thousand daily, upon schedule time, and with a headway varying from three to three and a half minutes. And this is done without accident or delay.

If it had been in use, the accident two or three years ago in the Harlem Tunnel and also that at Spuyten Duyvil, in which Senator Wagner and others were killed, could not have occurred.

The English Government, through the Board of Trade, obliges all English railroads to adopt the block system, and run their trains by it, and we should follow their example. The officers of a railroad should be tried and convicted of premeditated murder in all cases of fatal accidents on their road that could have been avoided by the block system. It is no excuse for them to say it does not answer, for it does answer perfectly in England and other European countries; the officers controlling the roads ought to be made to feel that it is cheaper and safer to properly equip the road by using the block system, than to kill or maim passengers by not doing so.

Speed.

English freight trains run much faster than ours; probably averaging twenty-five miles an hour.

The passenger trains are generally faster, especially for short runs; but, owing to the small size of the island, there are no such trains as the New York and Chicago or the New York and St. Louis Express.

Table No. 1 gives the fastest trains on the principal roads of each country.

Baggage Checks.

These are still unknown in England. Some of the large railroads will receive baggage and deliver it at a given destination for a charge of sixpence for each package, provided the places at which it is received and delivered are both on their line, and are large places, such as London, Liverpool, Manchester, etc. There is nothing like our through check system over many distinct lines. This would be a very great convenience to those who have to travel in England, as the care of the baggage requires constant attention to see that some one else does not take it. It is placed in the baggage car without any distinctive mark of ownership, and subject to the call of the first claimant. Yet one seldom hears of its loss. This speaks well for the honesty of the English people.

The railroad managers and superintendents seem averse to making any change, even if it would promote the comfort of the traveler, and thereby induce increased travel. Some oppose the introduction of the check system for fear that the road would lose by being held responsible for lost baggage. In vain the author quoted to them the experience of the Pennsylvania Railroad, which handled in 1883 the baggage of over 23 000 000 passengers, amounting to nearly 2 000 000 pieces, and only had to pay in the whole year for lost and damaged baggage $1 262.03.

The English railroads could save a large expense by adopting the American baggage check system, as it would enable them to dispense with a large force of porters now employed in loading and unloading the baggage of passengers. Eighty per cent. of this labor would be done by the baggage express or transfer companies free of charge to the railroads.

TABLE No. 1.

Table showing the Fastest Speed made by Regular Trains on English and American Railroads between Terminal or Important Stations—Time-tables, June, 1885.

Names of Railroads.	From	To	Distance in Miles.	Time, Including Stoppages.		Average Miles per Hour, Including Stoppages.
				Hours.	Minutes.	
English Railroads.						
London and North Western	London	Liverpool	201.75	4	30	44.8
" "	"	Glasgow	406	10	30	40.6
" "	"	Edinburgh	401	9	55	40.4
" " (Wild Irishman)	"	Holyhead	264	6	5	43.4
Great Northern	"	Glasgow	444	10	20	43.0
" (Flying Scotchman)	"	York	188.25	3	55	48.1
"	"	Edinburgh	397	9	55	44.1
Great Western	"	Swansea	216	6	55	36.0
" (Flying Dutchman)	"	Bristol	118.5	2	36	45.6
London, Brighton and South Coast	"	Brighton	50	1	5	46.2
" " "	"	Dover	76.5	1	40	45.9
Midland	"	Nottingham	125	2	30	50.0
London, Chatham and Dover	"	Dover	77.75	1	48	43.2
American Railroads.						
New York, New Haven and Hartford	Boston	New York	234	6	0	39.0
New York and New England	"	"	227	6	0	37.8
Pennsylvania	Jersey City	Philadelphia	89	1	57	45.6
"	"	Pittsburgh	443	11	15	39.4
"	"	Chicago	911	24	45	36.8
New York Central and Hudson River	New York	Albany	143	3	15	44.0
" " "	"	Buffalo	441	10	45	41.0
" " "	"	Chicago	980	25	0	39.2
Central of New Jersey	Jersey City	Philadelphia	89	1	52	47.7
Baltimore and Ohio	Baltimore	Washington	40	0	45	53.9

Comfort in Traveling.

In the opinion of the writer this is not so great in England as with us. In addition to the trouble with the baggage, there is the discomfort of riding in winter in a cold car, obliging one to wrap up even for a short journey as if he was going to the Arctic Regions. No attempt at warming has been made, except by hot-water pans to the feet. Another serious inconvenience is the difficulty of getting information while *en route*, owing to the want of communication between the different compartments. It is impossible to ask questions of the train hands whilst in motion, and during the few limited stops at stations the employees are busy with their duties and endeavoring to answer the questions of many others in similar want of information. The writer once traveled from London to Gloucester, 114 miles, without being able to find out the destination of the car he was in.

Unless one is bound for a terminal station, he is obliged to be constantly on the alert, or he is apt to be carried beyond his destination. The train hands generally call out the names of the stations, but in so disguised and mispronounced a manner that they are unrecognizable. At stations there is often no one previous to the arrival of the train except the gatekeeper, who is generally a long distance off, up or down a flight of stairs, that can give any information about the trains.

The Board of Trade requires that a sign, with the name, must be placed at each station; but as station advertising is carried to a great extent throughout England, it is very difficult to recognise the station sign from the hundreds of advertisements, equally conspicuous, of "Pears' Soap," "Lorne Whiskey," "Coleman's Mustard," etc., surrounding the name of the station.

Ton and Passenger Mileage.

No return of these all-important items for comparison is made in England. The author, after careful inquiry and investigation, decided that the average freight charge on all freight moved in the United Kingdom was about 1¼ pence, or 2.5 cents per mile per ton; but, in order to be conservative, he has taken the average charge at 1 penny, or 2 cents per ton per mile.

In order to get the ton mileage, the receipts from freight, as reported by the companies, in pounds sterling has been multiplied by 240.

The author thinks, as do most of the persons with whom he has con-

sulted, that the average freight charge of $0.02 or 1 penny per mile per ton is too low by at least one-fourth; $0.025 or 1¼ pence would be nearer the correct amount. This more than makes up the difference between the English ton of 2 240 pounds and the American ton of 2 000 pounds. The English tonnage returns are all given in tons of 2 240 pounds, while the American returns are all in tons of 2 000 pounds.

Mr. J. S. Jeans, the able Secretary of the Iron and Steel Institute of England, who is very justly regarded as one of the most able statisticians of Great Britain, estimates that the average freight charge per mile on minerals is $0.015 or .75 pence per ton per mile. This would make the preceding average charge on all classes of freight of $0.02 or 1 penny per mile much too small.

The passenger mileage has been obtained by dividing the reported total receipts from ordinary passengers by the total number transported. This gives the average amount received from each passenger. Divide this by $0.0233*, gives the average mileage traveled by each passenger. Multiplying this by the number transported, gives the total mileage of ordinary passengers. In order to save labor and time, many of the following calculations for passenger mileage were made by multiplying the total reported receipts in pounds sterling from ordinary passengers by 206, the estimated average number of miles that can be traveled for each pound paid.

The mileage of the holders of season tickets has been ascertained by comparing the schedule lists of prices for season tickets as issued by the different railroads leading into London, with the distances; the average price is found to be about $0.009 or .45 pence per mile—say, $0.008 or .4 pence. This makes 600 miles as the average mileage traveled for each pound sterling reported as received from the sale of season tickets. Multiplying this reported amount by 600, gives the total mileage traveled by the holders of season tickets. Adding this to the total mileage of the ordinary passengers, gives the total mileage of all passengers.

It is very unfortunate for comparison that the English railroads do not report the passenger or ton mileage. The preceding figures have been adopted after careful inquiry and examination, and can be considered approximatively reliable until changed by official data from the companies.

*One and one-sixth pence being the estimated charge per passenger per mile on all the English railroads, first, second and third-class included, exclusive of season tickets.

The passenger and ton mileage for the American railroads have been taken from the official reports of the companies or from the reports of the Railroad Commissioners of the different States, and are reliable.

ACCIDENTS.

TABLE No. 2.

Passengers Killed and Injured from causes beyond their own control on all the Railroads of the United Kingdom, and those of the States of New York and Massachusetts in 1884.

	TOTAL LENGTH OF LINE OPERATED.	TOTAL MILEAGE.			KILLED.	INJURED.
		Train.	Passenger.	Ton.		
United Kingdom..........	18 864	272 803 220	6 042 659 990	9 040 942 080	31	864
New York.................	7 296	85 918 677	1 729 653 620	9 322 518 571	10	124
Massachusetts............	2 852	82 304 333	1 007 136 376	1 229 368 472	2	42

		KILLED.	INJURED.
In 1 000 000 000 passengers transported 1 mile.......	United Kingdom..................................	5.15	143
	New York..................................	5.78	70
	Massachusetts..................................	2.00	42
In 1 000 000 000 tons transported 1 mile...........	United Kingdom..................................	3.44	96
	New York..................................	1.11	14
	Massachusetts..................................	1.63	34

		Miles.
The average number of miles a passenger can travel without being killed....................	United Kingdom..................................	194 892 255
	New York..................................	172 965 362
	Massachusetts..................................	503 568 188
The average number of miles a passenger can travel without being injured....................	United Kingdom..................................	6 992 662
	New York..................................	13 940 754
	Massachusetts..................................	28 955 630

This table shows the comparative magnitude of the American railroad system. One single State has over 40 per cent. of the miles of railroad that the United Kingdom has, and transports more freight and nearly 30 per cent. of as many passengers.

The Board of Trade of England publish annually very complete returns of accidents on all their railroads. Unfortunately there are no such returns available for all the American roads.

The Railroad Commissioners of Massachusetts and New York make very complete returns for their States, which can be taken as a fair sample of the old and completed roads of the United States. The new

roads of the West will show a much higher percentage of accidents, owing to being open to traffic generally during construction—and being generally not so well built.

Table No. 2 was constructed from the preceding data, and the reports of the English Board of Trade, and of the Railroad Commissioners of New York and Massachusetts.

Cost of Railroads.

A casual observation shows that the English railroads cost much more than the American in their construction. It is evident that the English engineer always had in view that there was behind him plenty of money, and abundance of time to spend it in. Apparently there was no necessity for studying an economical alignment—heavy cuts and fillings or long bridges and tunnels, did not appear to frighten him at all; his ideal line was a straight line and dead level, and he kept as near this as circumstances would permit. This expensive construction, with apparently straight lines and easy grades, good road-bed, permanent brick buildings, and brick, stone or iron bridges, should make the annual expenses much lighter than on our roads, where perishable materials, for economical reasons, enter so largely into our buildings, bridges, etc., requiring frequent renewals.

The question naturally arises: Do the working results compensate for this great additional cost of the English over our railroads? In other words, "Does it pay?" To ascertain this, we must analyze the working expenses of each system; this is not an easy undertaking, as the published reports of the two countries do not correspond in form or outline. Unfortunately, the returns of the English railroads made to the Board of Trade, and the annual reports of the different companies, are not as thorough as one would wish for comparison. They do not give the quantity or cost of coal consumed, or separate the cost of freight or passenger traffic, or give the total or average ton and passenger mileage.

In order that you may investigate for yourselves, the problem whether it pays or not to spend so much money in constructing railroads, the Tables from No. 3 to No. 17 have been made, showing the operating expenses of all the railroads in the aggregate, and also of a few of the principal roads of each country. The principal, if not the only, advantage of expensive over cheap construction, is to reduce the operating expenses; to ascertain to what extent this has been done, in the

following accounts of the operating expenses all items of expense that are in any way affected by good or bad construction, have been added together, and the percentage calculated to the whole operating expenses. This percentage will naturally be larger in cheaply constructed roads with sharp curves and steep grades, and built with perishable materials, than in the expensively built roads in which money has been freely spent to reduce curves and grades, and in the use of more durable materials.

Mr. Jeans, the able statistician of England, makes this percentage 59.66 for all the American railroads. This has been taken by the author as the average standard of all the railroads in the United States; to this standard the English roads have been compared. The percentage of the individual American roads has been worked out from data contained in their annual reports, or from the reports of the Railroad Commissioners of the different States.

TABLE No. 3.

Comparative Proportion of Different Items of Operating Expenses, that are or are not Affected by Good or Bad Construction, on the Aggregate Railroads of the United Kingdom and United States for the year 1880.

1880.	United Kingdom.		United States.	
	Expenses that are Affected by good or bad Construction.	Expenses that are not Affected by Good or Bad Construction.	Expenses that are Affected by Good or Bad Construction.	Expenses that are not Affected by Good or Bad Construction.
Maintenance of Way	$17.70	....	$25.31	
Locomotive Charges	24.40	....	24.96	
Repairs of Carriages	8.40	....	9.39	
Traffic Charges	....	$30.00	....	$25.31
Rates and Taxes	....	5.00	....	4.77
Government Duty	....	2.40	....	
Compensation—Passengers	....	.70	....	.39
Do. Goods	....	.60	....	.59
Legal and Parliamentary Expenses	....	.90	....	.70
Miscellaneous Expenses	....	9.90	....	8.58
Totals	$50.50	$49.50	$59.66	$40.34

This, and the two following tables, have been taken from a report recently made by Mr. J. S. Jeans, Secretary of the Iron and Steel Institute of Great Britain. Mr. Jeans is justly regarded as very good authority, and one of the most capable statisticians in this branch in England.

TABLE No. 4.

Showing the Number of Persons Employed on the Railroads of the United Kingdom and the United States in 1880.

1880.	United Kingdom.	United States.
Engine-drivers and Firemen	27 441	67 231
Guards	12 064	12 419
Plate-layers (Track-layers)	26 156	
Pointsmen, etc. (Switchmen)	7 406	122 489
Laborers	42 212	
Other railway servants	120 437	216 818
Totals	235 716	418 957
Average employés per 1 000 miles of goods and passenger trains	0.89	1.66
Average employés per mile of line open	13.	4.8
Average employés per 1 000 tons of traffic	0.9	0.7
Average employés per 1 000 passengers carried	0.38	0.65
Average employés per £1 000 earned	2.7	0.28

TABLE No. 5.

Showing the Rolling Stock used on Railroads of United Kingdom and United States in 1880.

1880.	United Kingdom.	United States.
Locomotives	14 469	17 412
Passenger Carriages	32 304	12 330
Freight Cars	446 333	375 312
Other Vehicles	12 024	84 613
Totals	505 130	489 667
Average vehicle per mile open	2.6	0.24
Average vehicle per 1 000 tons freight carried	0.5	0.59
Average vehicle per 1 000 passengers carried	1.3	0.53
Average vehicle per $5 000 capital	1.5	2.3

In the following Tables of the English Railroads, their percentage has been subtracted from 59.66, the average percentage of the American roads. This difference in the percentage, multiplied into the whole operating expenses, shows the gross saving by being well constructed. This divided by the number of miles operated, shows the annual saving per mile by the superior English over the inferior American construction. This amount capitalized at six per cent., shows the amount that the engineer would have been justified in expending per mile in construction over the cost of the inferior American system.

TABLE No. 6.

Operating Expenses of all the Railroads of the United Kingdom.

Year ending December 31st, 1883. Length of all Roads Operated, 18 681 Miles. Gauge, 4' 8½". Total cost, $3 777 808 395. Average Cost per Mile, $202 227.	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Maintenance of way, works, etc	$33 718 990	
Locomotive power, including stationary engines, etc	46 506 335	
Repairs and renewals of passenger and freight cars	16 476 835	
Traffic expenses, freight and passenger	....	$56 061 995
General charges	....	8 118 705
Rates and taxes	....	9 304 245
Government duty	....	3 696 280
Compensation for personal injury	....	1 235 160
Compensation for damage and loss of goods	....	989 705
Legal and Parliamentary expenses	....	1 865 925
Steamboat and harbor expenses	....	6 624 780
Sundries	....	2 269 410
Totals ($186 868 365)	$96 702 160	$90 166 205
Percentage	51.8	48.2
Percentage, average of all American railroads in 1880	59.7	
Percentage in favor of all the railroads of the United Kingdom	7.9	

Total saved by all the railroads of the United Kingdom, $186 868 365 × .079 = $14 762 600
Average saving per mile, $14 762 600 ÷ 18 681 = ... 790
Annual cost of $790 capitalized at 6 per cent = ... 13 167

TABLE No. 7.

Operating Expenses of the Great Eastern Railway of England.

Year ending December 31st, 1883. Length of Line Operated, 1 049 Miles. Gauge, 4' 8½".	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Maintenance of way	$1 481 740	
Locomotive power (including stationary engines)	2 575 085	
Repairs and renewals of passenger and freight cars	764 335	
Traffic expenses—freight and passenger	....	$2 953 350
General charges	....	387 070
Rates and taxes	....	489 975
Government duty	....	256 010
Compensation for personal injury	....	84 795
Compensation for damage and loss of goods	....	55 210
Legal and Parliamentary expenses	....	76 020
Sundries	....	810
Totals (*$9 074 400)	$4 821 160	$4 253 240*
Percentage	53.0	47.0
Percentage, average of all American railroads	59.7	40.3
Percentage in favor of Great Eastern Railway	6.7	

Total saved by Great Eastern Railway on operating 1 049 miles of railroad $9 074 400 × .067 = ... $607 985
Average saving per mile, $607 985 ÷ 1 049 = ... 580
Annual cost of $580 capitalized at 6 per cent. = ... 9 660

* The cost of operating the steamboats, etc. ($899 430), has been deducted as not properly belonging to the railroad service.

TABLE No. 8.

Operating Expenses of the Great Northern Railway of England.

Year ending December 31st, 1883. Length of Line Operated, 768 Miles. Gauge, 4' 8½".	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Maintenance of way, works, etc.	$1 616 115	
Locomotive power (including stationary engines)	2 637 645	
Repairs and renewals of passenger and freight cars	842 130	
Traffic expenses—Freight and passenger		$3 326 745
General charges		493 245
Rates and taxes		533 745
Government duty		168 530
Compensation for personal injury		149 290
Compensation for damage and loss of goods		70 320
Legal and Parliamentary expenses		58 765
Steamboat, canal and harbor expenses		58 900
Sundries		91 610
Totals ($10 047 040)	$5 095 890	$4 951 150
Percentage	50.7	49.3
Percentage, average of all American railroads	59.7	40.3
Percentage in favor of Great Northern Railway	9.0	....

Total saved by Great Northern Railway on operating 768 miles of road $10 047 040 × .09 = ... $904 234
Average saving per mile, $904 234 ÷ 768 = ... 1 177
Annual cost of $1 177 capitalized at 6 per cent. = ... 19 617

TABLE No. 9.

Operating Expenses of the Midland Railway of England.

Year ending December 31st, 1883. Length of Line Operated, 1 793 Miles. Gauge, 4' 8½".	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Maintenance of way, works, etc.	$3 276 645	
Locomotive power (including stationary engines).	5 342 330	
Repairs and renewals of passenger and freight cars	2 069 555	
Traffic expenses—Freight and passenger		$6 413 915
General charges		713 350
Rates and taxes.		957 475
Government duty		264 810
Compensation for personal injury, etc.		27 530
Compensation for damage and loss of goods		115 485
Legal and Parliamentary expenses		87 205
Sundries		135 495
Steamboat and harbor expenses		9 590
Totals ($19 413 385)	$10 688 530	$8 724 855
Percentage	55.1	44.9
Percentage, average of all American roads	59.7	40.3
Percentage in favor of Midland Railway	4.6	....

Total saved by Midland Railway on operating 1 793 miles, $19 413 385 × .046 = ... $893 016
Average saving per mile, $893 016 ÷ 1 793 = ... 647
Annual cost of $647 capitalized at 6 per cent = ... 10 777

TABLE No. 10.

Operating expenses of the London and North Western Railway of England.

Year ending December 31st, 1882. Length of Line Operated, 1 793 Miles. Gauge, 4' 8½''.	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Maintenance of way, works, etc.	$4 751 885	
Locomotive power (including stationary engines).	6 148 560	
Repairs and renewals of passenger and freight cars.	1 670 015	
Traffic expenses—Freight and passenger.	....	$9 787 585
General charges.	....	1 286 520
Rates and taxes.	....	1 178 800
Government duty.	....	629 040
Compensation for personal injury, etc.	....	149 665
Compensation for damage and loss of goods.	....	191 140
Legal and Parliamentary expenses.	....	275 485
Sundries.	....	137 730
Totals (*$26 156 426).	$12 570 460	*$13 585 965
Percentage.	48.0	52.0
Percentage, average of all American railroads in 1880.	59.7	....
Percentage in favor of London and North Western Railway.	11.7	....

Total saved by London and North Western Railway on operating 1 793 miles of railway, $26 904 425 × .117 =	$3 147 821
Average saving per mile, $3 147 821 ÷ 1 793 =	1 756
Annual cost of $1 756 capitalized at 6 per cent. =	29 267

TABLE No. 11.

Operating Expenses of the Great Western Railway of England.

Year ending December 31st, 1883. Length of Line Operated, 2 268 Miles. Gauge, 7' and 4' 8½".	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Maintenance of way, works, etc.	$4 497 670	
Locomotive power, including stationary engines.	4 822 400	
Repairs and renewals of passenger and freight cars.	1 533 820	
Traffic expenses—Freight and passenger.	....	$5 361 685
General charges.	....	763 285
Rates and taxes.	....	949 255
Government duty.	....	599 095
Compensation for personal injury.	....	39 585
Compensation for damage and loss of goods.	....	153 680
Legal and Parliamentary expenses.	....	258 035
Sundries.	....	210
Totals († $18 978 720).	$10 853 890	†$8 124 830
Percentage.	57.2	42.8
Percentage, average of all American roads.	59.7	40.3
Percentage in favor of Great Western Railway.	2.5	....

Total saved by Great Western Railway on operating 2 268 miles of railroad, $18 978 720 × .025 =	$474 468
Average saving per mile, $474 468 ÷ 2 268 =	209
Annual cost of $209 capitalized at 6 per cent =	3 483

* The cost of operating the steamboats, etc. ($748 030), has been deducted, as not properly belonging to the cost of operating the railroad.

† The cost of operating the steamboats, etc., $942 515, is not included, as not properly belonging to the cost of operating the railroad.

TABLE No. 12.

Operating Expenses of the Baltimore and Ohio Railroad.

Year ending September 30th, 1883. Length of Line Operated, 553 Miles. Gauge, 4' 8½''.	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
General expenses	....	$200 733.89
Losses by accidents, etc	$56 609.68	
Repairs of railroad	796 575.85	
Repairs of water stations	13 039.13	
Repairs and construction of depots	186 663.06	
Repairs of bridges	58 574.31	
Repairs of telegraph line	76 781.20	
Repairs of stationary machinery	118 276.66	
Watching cuts	....	30 546.15
Watching tunnels	....	5 451.67
Watching bridges	....	18 736.58
Pumping water	28 217.28	
Repairs of locomotives	624 146.36	
Repairs of passenger cars	299 386.71	
Repairs of freight cars	709 028.67	
Cleaning engines and cars	....	92 415.36
Contingent expenses of the machinery department	7 186.12	
Fuel	319 143.36	
Preparing fuel and filling tenders	20 096.37	
Pay of tonnage engineers	228 365.55	
Pay of tonnage firemen	105 505.61	
Pay of passenger engineers	82 812.24	
Pay of passenger firemen	40 013.25	
Expenses of transportation, salaries of agents, telegraph operators, clerks, station expenses, etc	....	2 029 350.74
Totals ($6 147 665.80)	$3 770 431.41	$2 377 234.39
Percentage	61.3	38.7

TABLE No. 18.

Operating Expenses of Pennsylvania Railroad. No. 1, Pennsylvania Division.

Main Line and Branches—Pittsburgh to Philadelphia.

Year ending December 31st, 1883. Gauge, 4′ 9″. Length of Road Operated, 1313.6 Miles.	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Conducting Transportation	....	$6 078 110.47
Motive Power	$5 237 379.22	
Maintenance of Cars	2 741 772.51	
Maintenance of Way	3 660 491.47	
General Expenses	....	603 659.89
Totals $18 321 413.56	$11 639 643.20	$6 681 770.36
Percentage	63.5	36.5

OPERATIONS.

Receipts from Freights	$24 778 190.15
Receipts from Passengers	5 989 625.35
Receipts from other Sources	1 249 997.79
Total Receipts from all Earnings	$32 017 813.29
Net Earnings from Operating	13 696 399.73
Total Mileage in this Division	1 313.53
Percentage of Operating Expenses to Earnings	57.22
Tonnage Moved	21 674 160
Tonnage Mileage	2 996 892 567
Average Ton Mileage	138.5
Average Earnings per Ton per Mile	$ .00819
Average Cost per Ton per Mile	.00477
Average Profit per Ton per Mile	.00342
Total Passengers Transported	10 697 474
Total Passenger Mileage	244 710 876
Average Passenger Mileage	$22\frac{8}{10}$ Miles.
Average Earnings from each Passenger per Mile	$ .02448
Average Cost of Transporting each Passenger 1 Mile	.01640
Average Profit per Passenger per Mile	.00808

TABLE No. 14.

Operating Expenses of Pennsylvania Railroad. No. 3, Philadelphia and Erie Railroad Division.

Year ending December 31st, 1883. Gauge, 4' 9". Length of Road Operated, 287.5 Miles.	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Conducting Transportation	....	$890 418.09
Motive Power	$762 468.99	
Maintenance of Cars	341 361.92	
Maintenance of Way	626 574.62	
Totals ($2 620 823.62)	$1 730 405.53	$890 418.09
Percentage	66.0	34.0

OPERATIONS.

Receipts from Freight	$3 352 417.79
Receipts from Passengers	667 742.66
Receipts from other Sources	88 682.71
Total Receipts from all Earnings	$4 108 843.16
Net Earnings from Operating	1 488 019.54
Percentage Operating Expenses to Earnings	63.8
Total Mileage in this Division	287.56
Tonnage Moved	5 154 935
Tonnage Mileage	520 249 716
Average Ton Mileage	100.9
Average Earnings per Ton per Mile	$ .00624
Average Cost per Ton per Mile	.00416
Average Profit per Ton per Mile	.00218
Total Passengers Transported	1 045 054
Total Passenger Mileage	21 908 174
Average Passenger Mileage	21 Miles.
Average Earnings from each Passenger per Mile	$ .03048
Average Cost of Transporting Each Passenger 1 Mile	.02075
Average Profit per Passenger per Mile	.00973

TABLE No. 15.

Operating Expenses of Pennsylvania Railroad. No. 2, New Jersey Division.

Year ending December 31st, 1883. Gauge, 4' 9". Length of Road Operated, 435 Miles.	Expenses that are affected by Good or Bad Construction.	Expenses that are not affected by Good or Bad Construction.
Conducting Transportation	....	$5 433 260.35
Motive Power	$2 618 034.64	
Maintenance of Cars	622 251.12	
Maintenance of Way	1 736 301.22	
General Expenses	....	103 491.37
Canal Expenses	....	291 574.56
Totals—Exclusive of Canal Expenses..($10 804 913.26)	$4 976 586.98	$5 828 326.28
Percentage—Excluding Canal Expenses	46.0	54.0

OPERATIONS.

Receipts from Freight	$8 269 943.20
Receipts from Passengers	5 542 247.22
Receipts from other Sources	1 144 405.23
Total Receipts from all Earnings	$14 956 595.65
Net Earnings from Operating	4 151 682.39
Total Mileage in this Division	435.07
Percentage of Operating Expenses to Earnings	72.95
Tonnage Moved	8 855 567
Tonnage Mileage	542 827 918
Average Ton Mileage	61.3
Average Earnings per Ton per Mile	$ .01471
Average Cost per Ton per Mile	.01167
Average Profit per Ton per Mile	.00304
Total Passengers Transported	11 339 380
Total Passenger Mileage	238 551 431
Average Passenger Mileage	21 Miles.
Average Earnings from each Passenger per Mile	$ .02074
Average Cost of Transporting each Passenger 1 Mile	.01571
Average Profit per Passenger per Mile	.00503

Few American engineers have the opportunity of seeing the English railroad reports. Tables 18, 19, 20 and 21 are exact reprints of all of that part of the semi-annual reports of the London and North Western Railway that relate to traffic for the years 1882, 1883 and 1884.

These will also enable those who are desirous, to make their own analysis of the data, as the author has done.

TABLE No. 16.

Railroads of the United Kingdom and of the United States Compared—1883.

Length of Lines Operated.	United Kingdom.		United States.		Remarks.
	Total.	Per Mile Operated.	Total.	Per Mile Operated.	
Single Track, miles	8 576				
Double or more Tracks	10 105				included.
Average Receipts from each passenger	$0.1881	....	$0.5475	....	do
Average mileage of each passenger, miles	....	8	....	22	
Average charge per mile for each passenger	....	$0.0233	....	0.0242	Estimated for United Kingdom.
Earnings.					
Earnings from Freight Traffic	$193 506 595	$10 359	$549 756 695	$5 000	
" " Passenger Traffic	128 712 260	6 890	221 633 082	2 007	
Total Earnings from Freight and Passenger Traffic	$322 218 855	$17 249	$771 389 777	$7 007	
" " " all sources	355 311 350	19 020	823 772 924	7 461	
Percentage of Gross Earnings to Investment, Capital and Bonds	9.05	....	10.99	....	This is on the inflated or watered stock of the American railroads.
Percentage of Net Earnings to Investment, Capital and Bonds.	4.29	....	4.49	....	
Operating Expenses of all Railroads operated	$186 842 810	$10 003	$486 861 040	4 410	
Percentage of Operating Expenses to Receipts	53.0	....	59.0		
Total Net Earnings	$168 468 540	$9 019	$336 911 884	$3 051	
Percentage of Net Earnings to Gross Receipts	47.0	....	41.0		
Passenger Earnings per Passenger Train mile	....	$0.925	....	$1.14	
Freight " " Freight " "	....	1.50	....	1.55	
Rolling Stock.					
Total Engines	14 469	.775	23 823	.216	
Total Passenger Cars	32 304	1.73	17 899	.162	
Total Baggage, Mail and Express Cars	2 024	.108	5 948	.054	
Total Freight Cars	446 333	23.90	748 661	6.78	

TABLE No. 18.—*Continued.*

(A) MAINTENANCE OF WAY, ETC.		£ s. d.	30th June, 1882.
Salaries, Office Expenses and General Superintendence	£19 841 8 4		18 559
Maintenance and Renewals of Permanent Way, viz.:			
Wages £138 979 0 7			130 290
Materials 48 715 7 10			55 337
Engines Ballasting 9 979 2 0			9 815
	197 673 10 5		195 442
Repairs of Approach Roads, Bridges, Signals, and other Works	57 515 16 7		57 699
Repairs of Stations and Buildings	35 229 4 3		31 991
		310 259 19 7	303 691
Rebuilding Stations		15 000 0 0	15 000
Repairs—Garston and Widnes Docks and Holyhead Harbor		6 017 3 3	3 953
" —St. Helens and Coalport Canals		2 825 19 7	2 899
Sundry Joint Lines and Stations		17 138 18 3	12 744
Signals, Sidings and Sundry Works		54 122 14 0	64 742
Miles Maintained: Double or more 1 310; Single 374	1 684		
		£405 364 14 8	403 029

(B) LOCOMOTIVE POWER.		£ s. d.	30th June, 1882.
Salaries, Office Expenses and General Superintendence		19 137 11 0	18 441
Running Expenses:			
Wages connected with the Working of Locomotive Engines	£227 274 6 3		214 795
Coal and Coke	135 437 19 4		123 419
Water	4 996 3 5		4 837
Oil, Tallow and other Stores	22 679 14 1		22 047
		390 388 3 1	365 098
Repairs and Renewals of Engines, Tools, etc.:			
Wages	£89 705 3 8		88 311
Materials	93 487 2 6		77 911
		183 192 6 2	166 222
Special Expenditures		11 009 18 5	15 839
Stationary Engines, Liverpool Tunnels		4 404 19 7	2 225
		608 132 18 3	567 825
Cr., Mileage of Sundry Trains	£12 085 9 4		
Less—Cromford and High Peak Working	3 694 13 7		
		8 390 15 9	10 865
		£599 742 2 6	556 990

(C) REPAIRS AND RENEWALS OF CARRIAGES AND WAGONS.		£ s. d.	30th June, 1882.
Carriages—Salaries, Office Expenses and General Superintendence	£1 636 18 10		1 624
Wages	37 429 11 4		33 480
Materials	53 197 7 9		58 819
		92 263 17 11	93 923
Wagons—Salaries, Office Expenses and General Superintendence	£2 382 6 3		2 382
Wages	17 872 9 1		18 047
Materials	46 447 18 10		49 629
		66 702 14 2	70 058
		£158 966 12 1	163 981

TABLE No. 18.—*Continued.*

Stores.	£	s.	d.	30th June, 1882.
Locomotive Department Stores	315 709	13	3	306 826
Locomotive Department Works in progress and Sundries	181 530	15	9	178 069
Carriage Department Stores	51 920	15	5	54 980
Carriage Department Sundries in process of manufacture	17 676	3	5	19 368
Wagon Department Store	107 071	11	6	97 212
Wagon Department Sundries in process of manufacture	14 138	9	2	10 691
Permanent Way Stores	418 727	5	7	370 700
Engineering Stores	63 894	6	9	68 761
General Stores	27 224	9	11	29 387
Steamboat Stores	9 148	18	1	12 659
Telegraph Stores	14 261	9	5	10 793
	1 221 303	18	3	1 159 446
Engineering Stores, Joint Lines	36 300	14	8	31 595
Total	£1 257 604	12	11	1 191 041

(D) Traffic Expenses.	£	s.	d.	£	s.	d.	30th June, 1882.
Salaries, Wages, etc., Coaching and Police Department	£224 209	9	6				215 044
Fuel, Lighting, Water and General Stores	59 000	13	7				60 670
Clothing	13 475	7	8				11 848
Printing, Stationery and Tickets	15 408	4	10				16 385
Joint Station Expenses	20 646	16	9				20 787
Horses, Harness, Parcel Carts, Provender, etc	11 836	9	1				11 389
				344 577	1	5	336 123
Salaries, Wages, etc., Merchandise Department	£419 710	8	10				411 042
Fuel, Lighting, Water, Grease and General Stores	28 480	6	5				26 017
Clothing	864	2	6				666
Printing, Stationery, etc	8 749	17	1				9 354
Horses, Harness, Vans, Provender, etc	96 802	7	7				99 322
Wagon Covers, Ropes, etc	12 495	14	9				11 307
Joint Station Expenses	9 502	18	9				6 746
Agents' Commission	1 895	10	6				1 990
Hoists, Hydraulic Cranes, etc	29 115	13	4				36 033
				607 616	19	9	592 477
				£952 194	1	2	928 600

(E.) General Charges.	£	s.	d.	£	s.	d.	June 30th, 1882.
Direction				4 537	10	0	4 538
Auditors and Public Accountants				900	17	2	993
Salaries of Secretary, General Manager, Accountants and Clerks	£32 400	8	10				
Office Expenses and Sundries	7 318	4	0				
				39 718	12	10	39 301
Advertising				2 039	17	6	1 670
Fire Insurance				6 905	6	8	6 905
Electric Telegraph Expenses				18 457	0	6	17 256
Railway Clearing House Expenses				15 289	14	10	14 446
Contribution to Superannuation Fund				6 294	13	2	6 279
Schools				1 162	6	8	943
Traveling Expenses, Directors, Managers, etc				1 688	16	5	1 869
Provident and Insurance Societies and Pension Fund				9 252	19	8	8 047
Sundry Expenses, not classed				7 965	2	0	7 213
				£114 212	17	5	109 460

TABLE No. 18.—*Continued.*

(F) STEAMBOAT EXPENSES.	£ s. d.	30th June, 1882.
Salaries of Commanders, Wages of Crews, etc.	19 142 5 11	19 310
Repairs, Ship Stores, etc.	6 118 14 1	5 798
Coal and Engineers' Stores	10 014 11 5	10 937
Light and Harbor Dues	7 089 9 6	7 176
General Charges	1 959 9 10	2 804
	44 324 10 9	46 025
Less—Cost of Working Greenore Service	10 048 0 0	9 856
	£34 276 10 9	36 169

STEAMBOAT DEPRECIATION AND INSURANCE ACCOUNT.

	£ s. d.		£ s. d.
To Balance 31st Dec. last	1 180 10 10	By Amount set aside from Revenue this half year	10 000 0 0
To Expended this half year	176 13 7		
To Balance	8 642 15 7		
	£10 000 0 0		£10 000 0 0

MILEAGE STATEMENT.

	Miles Authorized.	Miles Constructed.	Miles Constructing or to be Constructed.	Miles Worked by Engines.	30th June, 1882.
Lines owned by Company	1 546½	1 505	41½	1 499½	1 490
Lines partly owned	74¼	73¼	1	140¾	140¾
Lines Leased or Rented	146½	142¾	3¾	213¾	213¾
Total	1 767¼	1 721	46¼	1 854	1 844½
Lines Worked	54	54	....	61¾	51½
Foreign Lines Worked over	....	....	....	560¾	569½
Total	1 821¼	1 775	46¼	2 476½	2 465½

STATEMENT OF TRAIN MILEAGE.

Passenger Trains	8 969 727	8 598 244
Goods and Mineral Trains	9 528 331	9 245 421
Total	18 498 058	17 843 665

TABLE No. 19.—*Continued.*

(A) MAINTENANCE OF WAY, ETC.			31st Dec., 1882.
		£ s. d.	
Salaries, Office Expenses and General Superintendence	£19 668 13 9	....	18 622
Maintenance and Renewal of Permanent Way, viz.:			
Wages £138 169 17 2			132 483
Materials 133 968 14 8			135 557
Engines Ballasting 11 771 15 1			10 989
	283 910 6 11		279 029
Repairs of Approach Roads, Bridges, Signals and other Works	62 614 10 7		66 057
Repairs of Stations and Buildings	36 167 8 10		41 651
		402 361 0 1	405 359
Rebuilding Stations		20 000 0 0	20 000
Repairs—Garston and Widnes Docks and Holyhead Harbor		7 959 11 9	5 360
Repairs—St. Helens and Coalport Canals		3 326 9 1	2 638
Sundry Joint Lines and Stations		14 619 3 2	14 668
Signals, Sidings and Sundry Works		72 972 16 2	70 269
Miles Maintained:			
Double or more 1 313			
Single 374			
—1 687		£521 239 0 3	518 294

(B) LOCOMOTIVE POWER.			31st Dec., 1882.
		£ s. d.	
Salaries, Office Expenses and General Superintendence		18 961 10 7	19 204
Running Expenses:			
Wages connected with the Working of Locomotive Engines	£231 897 17 7		222 446
Coal and Coke	141 819 12 7		129 778
Water	4 728 2 8		4 563
Oil, Tallow and other Stores	27 292 15 2		22 725
		405 738 8 0	379 512
Repairs and Renewals of Engines, Tools, etc.:			
Wages	£90 774 9 6		94 064
Materials	93 885 4 8		84 624
		184 659 14 2	178 688
Special Expenditure		15 471 12 10	27 022
Stationary Engine, Liverpool Tunnels		3 653 3 2	2 167
Cr., Mileage of Sundry Trains	£14 288 6 10	628 484 8 9	606 593
Less—Cromford and High Peak Working	3 313 2 4		
		10 975 4 6	11 631
		£617 509 4 3	594 962

(C) REPAIRS AND RENEWALS OF CARRIAGES AND WAGONS.			31st Dec., 1882.
		£ s. d.	
Carriages—Salaries, Office Expenses and General Superintendence	£1 675 1 10		1 601
Wages	34 121 6 5		34 680
Materials	62 566 19 3		60 532
		98 363 7 6	96 813
Wagons—Salaries, Office Expenses and General Superintendence	£2 328 6 10		2 328
Wages	18 518 14 10		20 486
Materials	52 142 10 2		50 894
		72 989 11 10	73 708
		£171 352 19 4	170 521

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Abstracts:

(A) To Maintenance of W
Works and Stations.....
(B) To Locomotive Power.....
(C) To Carriage and Wagon
pairs ....
To Mileage of Carriages
Wagons of other Con
nies......................
(D) To Traffic Expenses.......
(E) To General Charges.......
To Law Charges...........
To Parliamentary Expense
To Compensation for A
dents and Losses:
Passengers......£19 397 1
Goods, etc...... 20 922 1

To Rates and Taxes.......
To Government Duty.....
To North Union Railway—
portion of Joint Expens
To Birkenhead Railway—
portion of Joint Expen
To Shrewsbury and Her
Railway—Proportio
Joint Expense.........
To Shrewsbury and Wel
ton Railway—Proporti
Joint Expense.........
To Shrewsbury and Welsh
Railway—Proportio
Joint Expense.........
To Vale of Towy Railw
Proportion of Joint Ex
(F) To Steamboat Expenses..
To Depreciation and Insur
of Steamboats..........
To Lancaster Canal Expe
To Huddersfield Canal
penses.................

To Balance carried to Net
enue Account.........

TABLE No. 19.—*Continned.*

STORES.	£ s. d.	31st Dec., 1882.
Locomotive Department Stores	322 450 18 6	321 355
Locomotive Department, Work in progress, and Sundries	191 302 9 0	198 768
Carriage Department Stores	54 448 13 6	56 251
Carriage Department, Sundries in process of manufacture	41 875 18 6	18 788
Wagon Department Stores	112 883 10 5	97 500
Wagon Department, Sundries in process of manufacture	16 143 7 5	14 601
Permanent Way Stores	441 260 2 4	426 865
Engineering Stores	35 526 2 3	38 544
General Stores	28 305 14 7	24 905
Steamboat Stores	10 302 0 9	9 280
Telegraph Stores	14 978 9 5	16 086
	1 269 477 6 8	1 222 943
Engineering Stores Joint Lines	36 455 15 4	29 171
Total	£1 305 933 2 0	1 252 114

(D) TRAFFIC EXPENSES.		£ s. d.	31st Dec., 1882.
Salaries, Wages, etc., Coaching and Police Departments	£236 307 18 7		230 377
Fuel, Lighting, Water and General Stores	57 194 10 2		59 032
Clothing	9 915 5 9		8 946
Printing, Stationery and Tickets	19 597 12 1		18 726
Joint Station Expenses	18 987 15 4		21 373
Horses, Harness, Parcel Carts, Provender, etc	10 983 17 10		14 087
		352 986 19 9	352 541
Salaries, Wages, etc., Merchandise Department	427 376 0 3		423 866
Fuel, Lighting, Water, Grease and General Stores	29 630 5 11		27 886
Clothing	712 2 4		841
Printing, Stationery, etc	9 198 15 5		8 842
Horses, Harness, Vans, Provender, etc	91 105 6 7		99 024
Wagon Covers, Ropes, etc	10 487 18 5		13 425
Joint Station Expenses	10 988 6 11		11 834
Agents' Commission	1 890 9 9		2 627
Hoists, Hydraulic Cranes, etc	30 350 3 10		28 289
		611 739 9 5	616 634
		£964 726 9 2	969 175

(E) GENERAL CHARGES.		£ s. d.	31st Dec., 1882.
Direction		4 537 10 0	4 538
Auditors and Public Accountants		897 12 1	964
Salaries of Secretary, General Manager, Accountants and Clerks	£32 522 10 2		
Office Expenses, Sundries	9 224 17 11		
		41 747 8 1	40 234
Advertising		3 629 17 3	3 029
Fire Insurance		13 810 13 4	13 811
Electric Telegraph Expenses		18 964 11 9	17 242
Railway Clearing House Expenses		16 909 15 6	15 911
Contributions to Superannuation Fund		6 312 1 1	6 113
Schools		1 303 4 6	872
Traveling Expenses, Directors, Managers, etc		1 544 8 5	1 792
Provident and Insurance Societies and Pension Funds		10 391 17 2	7 556
Sundry Expenses, not classed		7 325 7 11	7 141
		£127 374 7 1	119 203

TABLE No. 19.—*Continued.*

(F) STEAMBOAT EXPENSES.	£ s. d.	31st Dec., 1882.
Salaries of Commanders, Wages of Crews, etc.	20 188 13 11	17 980
Repairs, Ship Stores, etc.	6 888 3 3	5 292
Coal and Engineers' Stores	10 156 3 11	11 247
Light and Harbor Dues	7 289 10 4	8 260
General Charges	2 651 13 0	2 398
	47 174 4 5	45 177
Less—Cost of Working Greenore Service	9 985 12 0	10 048
	£37 188 12 5	35 129

STEAMBOAT DEPRECIATION AND INSURANCE ACCOUNT.

	£ s. d.		£ s. d.
To Expended this Half-year.	610 0 0	By Balance 30th June last...	8 642 15 7
To cost of new cattle steamer Holyhead, lost 30th October last	35 817 3 11	By Amount set aside from Revenue this Half-year...	15 000 0 0
		By Balance	12 784 8 4
	£36 427 3 11		£36 427 3 11

MILEAGE STATEMENT.

	Miles Authorized.	Miles Constructed.	Miles Constructing or to be Constructed.	Miles Worked by Engines.	31st Dec., 1882.
Lines owned by Company.	1 570½	1 524¼	46¼	1 519	1 493
Lines partly owned	80½	79½	1	152	140¾
Lines Leased or Rented...	146½	142¾	3¾	213¾	213¾
Total	1 797½	1 746½	51	1 884¾	1 847½
Lines Worked	30¾	30¾	..	33¾	51½
Foreign Lines Worked over	......	......	..	562¾	560¾
Total	1 828¼	1 777¼	51	2 481¼	2 459¾

STATEMENT OF TRAIN MILEAGE.

Passenger Trains	9 796 002	9 389 561
Goods and Mineral Trains	9 802 718	9 547 258
Total	19 598 720	18 936 819

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Abstracts:

(A) To Maintenance of Way, and Stations.........
(B) To Locomotive Power..
(C) To Carriage and Wag pairs..... ....
To Mileage of Carriag Wagons of other com
(D) To Traffic Expenses....
(E) To General Charges....
To Law Charges........
To Parliamentary Expe
To Compensation for Ac and Losses:
Passengers.. £11 50
Goods, etc.. 19 35

To Rates and Taxes ...
To Government Duty .
To North Union Railwa portion of Joint Expe
To Birkenhead Railwa portion of Joint Expe
To Shrewsbury and H Railway—Proportion Expenses............
To Shrewsbury and Wel Railway—Proportion Expenses. ....
To Shrewsbury and We Railway—Proportion Expenses............
To Vale of Towy Ra Proportion of Joi penses..............
(F) To Steamboat Expense
To Depreciation and In of Steamboats.......
To Lancaster Canal Ex
To Huddersfield Ca penses.............

To Balance carried Revenue Account...

TABLE No. 20.—*Continued.*

(A) MAINTENANCE OF WAY, ETC.		£ s. d.	30th June, 1883.
Salaries, Office Expenses and General Superintendence	£20 018 9 8		19 841
Maintenance and Renewal of Permanent Way, viz.:			
Wages £136 112 18 2			138 979
Materials 48 402 7 1			48 716
Engines Ballasting 10 270 18 5			9 979
	194 786 3 8		197 674
Repairs of Approach Roads, Bridges, Signals and other Works	62 235 7 6		57 516
Repairs of Stations and Buildings	33 679 4 9		35 229
		310 719 5 7	310 260
Rebuilding Stations		15 000 0 0	15 000
Repairs—Garston and Widnes Docks and Holyhead Harbor		7 614 17 1	6 017
Do. St. Helens and Coalport Canals		3 380 16 8	2 826
Sundry Joint Lines and Stations		16 467 1 2	17 139
Signals, Sidings and Sundry Works		53 903 18 11	54 123
Miles Maintained: Double or more 1 321			
Single 370			
1 691		£407 085 19 5	405 365

(B) LOCOMOTIVE POWER.		£ s. d.	30th June, 1883.
Salaries, Office Expenses and General Superintendence		19 985 6 8	19 138
Running Expenses:			
Wages connected with the Working of Locomotive Engines	£225 699 9 11		227 274
Coal and Coke	142 353 15 10		135 438
Water	4 237 5 3		4 996
Oil, Tallow and other Stores	24 071 15 0		22 680
		396 362 6 0	390 388
Repairs and Renewals of Engines, Tools, etc.:			
Wages	£88 079 3 2		89 705
Materials	105 272 5 3		93 487
		193 351 8 5	183 192
Special Expenditure		10 914 14 0	11 010
Stationary Engines, Liverpool Tunnels		3 537 13 6	4 405
		624 151 8 7	608 133
Cr., Mileage of Sundry Trains	£15 194 15 10		
Less—Cromford and High Peak Working	4 432 8 7		
		10 762 7 3	8 391
		£613 389 1 4	599 742

(C) REPAIRS AND RENEWALS OF CARRIAGES AND WAGONS.		£ s. d.	30th June, 1883.
Carriages—Salaries, Office Expenses and General Superintendence	£1 752 8 4		1 637
Wages	38 523 4 6		37 430
Materials	78 185 17 4		53 197
		118 461 10 2	92 264
Wagons—Salaries, Office Expenses and General Superintendence	£2 396 12 9		2 382
Wages	18 728 3 7		17 873
Materials	46 132 2 0		46 448
		67 256 18 4	66 703
		£185 718 8 6	158 967

TABLE No. 20.—*Continued.*

Stores.	£	s.	d.	30th June, 1883.
Locomotive Department Stores	316 744	6	1	315,710
Do. Works in progress, and Sundries	186 327	4	7	181 531
Carriage Department Stores	58 834	17	7	51 921
Do. Sundries in process of manufacture	38 508	4	1	17 676
Wagon Department Stores	118 707	4	3	107 072
Do. Sundries in process of manufacture	20 649	16	6	14 138
Permanent Way Stores	458 299	13	6	418 727
Engineering Stores	68 887	3	11	63 894
General Stores	29 131	12	9	27,224
Steamboat Stores	14 404	4	8	9 149
Telegraph Stores	14 492	0	5	14 261
	1 324 986	8	4	1 221 303
Engineering Stores, Joint Lines	33 539	16	6	36 301
Total	£1 358 526	4	10	1 257 604

(D) Traffic Expenses.	£	s.	d.	£	s.	d.	30th June, 1883.
Salaries, Wages, etc., Coaching and Police Departments	£230 779	16	7				224 209
Fuel, Lighting, Water and General Stores	62 956	11	1				59 001
Clothing	12 547	0	9				13 475
Printing, Stationery and Tickets	14 865	3	8				15 408
Joint Station Expenses	18 689	16	7				20 647
Horses, Harness, Parcel Carts, Provender, etc	11 648	18	5				11 837
				351 487	7	1	344 577
Salaries, Wages, etc., Merchandise Department	416 285	8	7				419 710
Fuel, Lighting, Water, Grease and General Stores	28 853	19	5				28 480
Clothing	735	1	6				864
Printing, Stationery, etc	9 024	0	4				8 750
Horses, Harness, Vans, Provender, etc	82 721	0	4				96 802
Wagon Covers, Ropes, etc	10 144	19	6				12 496
Joint Station Expenses	10 834	13	11				9 503
Agents' Commission	1 964	11	8				1 896
Hoists, Hydraulic Cranes, etc	29 837	4	6				29 116
				590 400	19	9	607 617
				£941 888	6	10	952 194

(E) General Charges	£	s.	d.	£	s.	d.	30th June, 1883.
Direction				4 537	10	0	4 538
Auditors and Public Accountants				913	18	4	901
Salaries of Secretary, General Manager, Accountants and Clerks	£33 508	2	0				
Office Expenses, Sundries	7 455	9	0				
				40 963	11	0	39 718
Advertising				1 964	15	2	2 040
Fire Insurance				6 905	6	8	6 905
Electric Telegraph Expenses				18 176	2	10	18 457
Railway Clearing House Expenses				14 798	2	4	15 290
Contribution to Superannuation Fund				6 472	13	7	6 295
Schools				1 185	13	5	1 162
Traveling Expenses Directors, Managers, etc				1 655	9	9	1 689
Provident and Insurance Societies and Pension Funds				11 662	14	11	9 253
Sundry Expenses, not classed				6 100	15	6	7 965
				£115 336	13	6	114 213

TABLE No. 20.—*Continued.*

(F) STEAMBOAT EXPENSES.	£ s. d.	30th June, 1883.
Salaries of Commanders, Wages of Crews, etc.	20 203 12 4	19 142
Repairs, Ship Stores, etc.	7 002 13 3	6 119
Coal and Engineers' Stores	10 784 15 3	10 015
Light and Harbor Dues	7 181 11 2	7 089
General Charges	2 363 7 2	1 960
	47 535 19 2	44 325
Less—Cost of Working Greenore Service	9 920 0 0	10 048
	£37 615 19 2	34 277

STEAMBOAT DEPRECIATION AND INSURANCE ACCOUNT.

	£ s. d.		£ s. d.
To Balance 31st Dec. last	12 784 8 4	By Amount set aside from Revenue this Half-year	10 000 0 0
To Expended this Half-year	438 16 9	By Balance	3 223 5 1
	£13 223 5 1		£13 223 5 1

MILEAGE STATEMENT.

	Miles Authorized.	Miles Constructed.	Miles Constructing or to be Constructed.	Miles Worked by Engines.	30th June, 1883.
Lines owned by Company	1 570½	1 528¾	41¾	1 523½	1 499½
Lines partly owned	80½	79½	1	152	140¾
Lines Leased or Rented	146½	142¾	3¾	213¾	213¾
Total	1 797½	1 751	46½	1 889¼	1 854
Lines Worked	30¾	30¾	.....	33¾	61¾
Foreign Lines Worked over	.....	....	.....	562¾	560¾
Total	1 828¼	1 781¾	46½	2 485¾	2 476½

STATEMENT OF TRAIN MILEAGE.

Passenger Trains	9 318 457	8 969 727
Goods and Mineral Trains	8 933 380	9 528 331
Total	18 251 837	18 498 058

TABLE No. 21.—*Continued.*

(A) MAINTENANCE OF WAY, ETC.		£ s. d.	31st Dec., 1883.
Salaries, Office Expenses, and General Superintendence	£19 145 19 2		19 669
Maintenance and Renewal of Permanent Way, viz.:			138 169
Wages £136 848 19 3			133 969
Materials 135 880 11 9			11 772
Engines Ballasting 11 010 7 2			
	283 739 18 2		283 910
Repairs of Approach Roads, Bridges, Signals, and other Works	70 029 13 1		62 615
Repairs of Stations and Buildings	40 745 10 2		36 167
		413 661 0 7	402 381
Rebuilding Stations		20 000 0 0	20 000
Repairs—Garston and Widnes Docks and Holyhead Harbor		6 719 5 0	7 960
Repairs—St. Helens and Coalport Canals		3 758 12 7	3 306
Sundry Joint Lines and Stations		17 420 3 4	14 619
Signals, Sidings, and Sundry Works		46 658 8 5	72 973
Miles Maintained:			
Double or more 1 334			
Single 370			
1 704		£508 217 9 11	521 239

(B) LOCOMOTIVE POWER.		£ s. d.	31st Dec., 1883.
Salaries, Office Expenses, and General Superintendence		19 421 7 6	18 962
Running Expenses:			
Wages connected with the Working of Locomotive Engines	£238 585 18 2		231 898
Coal and Coke	140 763 11 0		141 819
Water	5 581 11 8		4 728
Oil, Tallow, and other Stores	27 256 11 6		27 293
		412 187 12 4	405 738
Repairs and Renewals of Engines, Tools, etc.:			
Wages	£90 523 2 4		90 774
Materials	96 598 6 4		93 885
		187 121 8 8	184 659
Special Expenditure		15 479 5 1	15 472
Stationary Engines, Liverpool Tunnels		3 724 9 1	3 653
		637 934 2 8	628 484
Cr., Mileage of Sundry Trains	£16 947 12 10		
Less—Cromford and High Peak Working.	2 914 16 5		
		14 032 16 5	10 925
		£623 901 6 3	617 509

(C) REPAIRS AND RENEWALS OF CARRIAGES AND WAGONS.		£ s. d.	31st Dec., 1883.
Carriages—Salaries, Office Expenses and General Superintendence	£1 695 2 1		1 675
Wages	38 096 3 3		34 121
Materials	72 543 19 2		62 567
		112 335 4 6	98.363
Wagons—Salaries, Office Expenses and General Superintendence	£2 353 8 0		2 328
Wages	22 743 10 2		18 519
Materials	46 621 4 8		52 143
		71 718 2 10	72 990
		£184 053 7 4	171 353

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Abstracts:

(A) To Maintenance of Wa
Works and Stations....
(B) To Locomotive Power...
(C) To Carriage and Wag
Repairs...............
To Mileage of Carriag
and Wagons of oth
Companies............
(D) To Traffic Expenses......
(E) To General Charges......
To Law Charges..........
To Parliamentary Expens
To Compensation for Ac
dents and Losses:
Passengers... £14 527 12
Goods, etc.... 22 386 2

To Rates and Taxes......
To Government Duty....
To North Union Railway
Proportion of Joint E
pense.................
To Birkenhead Railway
Proportion of Joint E
pense .. ..
To Shrewsbury and He
ford Railway—Proporti
of Joint Expense.......
To Shrewsbury and W
ington Railway — Pr
portion of Joint Expens
To Shrewsbury and Wels
pool Railway — Prop
tion of Joint Expense.
To Vale of Towy Railw
—Proportion of Joint E
pense..................
(F) To Steamboat Expenses..
To Depreciation and Insu
ance of Steamboats ...
To Lancaster Canal E
penses..................
To Huddersfield Canal E
penses..................

To Balance carried to N
Revenue Account......

TABLE No. 21.—*Continued.*

Stores.	£	s.	d.	31st Dec., 1883.
Locomotive Department Stores	344 406	18	6	322 451
Locomotive Department, Work in progress and Sundries	208 191	0	4	191 302
Carriage Department Stores	61 125	14	0	54 449
Carriage Department, Sundries in process of manufacture	28 740	5	6	41 876
Wagon Department Stores	120 237	4	6	112 884
Wagon Department, Sundries in process of manufacture	13 370	1	8	16 143
Permanent Way Stores	483 480	3	4	441 260
Engineering Stores	35 179	4	1	35 526
General Stores	27 350	15	8	28 306
Steamboat Stores	12 333	14	4	10 302
Telegraph Stores	13 637	0	10	14 978
	1 348 052	2	9	1 269 477
Engineering Stores, Joint Lines	35 482	11	6	36 456
Total	£1 383 534	14	3	1 305 933

(D) Traffic Expenses.		£	s.	d.	31st Dec., 1883.
Salaries, Wages, etc., Coaching and Police Departments	£239 839 12 5				236 308
Fuel, Lighting, Water and General Stores	59 793 13 6				57 195
Clothing	10 456 4 7				9 915
Printing, Stationery and Tickets	20 503 4 11				19 598
Joint Station Expenses	16 327 7 7				18 987
Horses, Harness, Parcel Carts, Provender, etc	10 336 13 8				10 984
		357 256	16	8	352 987
Salaries, Wages, etc., Merchandise Department	£427 934 11 11				427 376
Fuel, Lighting, Water, Grease, and General Stores	28 836 1 5				29 680
Clothing	816 13 1				712
Printing, Stationery, etc	8 886 11 7				9 199
Horses, Harness, Vans, Provender, etc	87 838 18 9				91 105
Wagon Covers, Ropes, etc	9 497 2 4				10 488
Joint Station Expenses	12 035 14 5				10 988
Agents' Commission	2 010 5 0				1 891
Hoists, Hydraulic Cranes, etc	23 626 14 3				30 350
		601 482	12	9	611 739
		£958 739	9	5	964 726

(E) General Charges.		£	s.	d.	31st Dec., 1883.
Direction		4 537	10	0	4 537
Auditors and Public Accountants		871	13	1	898
Salaries of Secretary, General Manager, Accountants and Clerks	£33 755 8 2				
Office Expenses, Sundries	8 814 14 2				
		42 570	2	4	41 747
Advertising		3 780	13	7	3 630
Fire Insurance		13 810	13	4	13 811
Electric Telegraph Expenses		18 051	3	5	18 965
Railway Clearing House Expenses		15 547	10	3	16 910
Contribution to Superannuation Fund		6 502	18	6	6 312
Schools		1 311	6	11	1 303
Traveling Expenses, Directors, Managers, etc		1 546	13	3	1 544
Provident and Insurance Societies and Pension Funds		12 124	13	3	10 392
Sundry Expenses, not classed		6 137	0	11	7 325
		£126 791	18	10	127 374

TABLE No. 21.—*Continued.*

(F) STEAMBOAT EXPENSES.	£ s. d.	31st Dec., 1883.
Salaries of Commanders, Wages of Crew, etc.	20 015 2 2	20 189
Repairs, Ship Stores, etc.	6 862 12 8	6 888
Coal and Engineers' Stores	10 773 10 5	10 156
Light and Harbor Dues	7 698 1 11	7 289
General Charge	2 596 3 4	2 652
	47 945 10 6	47 174
Less—Cost of Working Greenore Service	10 048 0 0	9 985
	£37 897 10 6	37 189

STEAMBOAT DEPRECIATION AND INSURANCE ACCOUNT.

	£ s. d.		£ s. d.
To Balance 30th June last	3 223 5 1	By Amount set aside from Revenue this Half-year	15 000 0 0
To Balance	13 301 14 11	By sale of the Telegraph	1 525 0 0
	£16 525 0 0		£16 525 0 0

MILEAGE STATEMENT.

	Miles Authorized.	Miles Construct'd	Miles Constructing or to be Constructed.	Miles Worked by Engines.	31st Dec., 1883
Lines owned by Company	1 576¼	1 542	34¼	1 532¼	1 519
Lines partly owned	86	85	1	163	152
Lines Leased or Rented	141	137	4	203	213¾
Total	1 803¼	1 764	39¼	1 898¼	1 884¾
Lines Worked	30¾	30¾	....	33¾	33¾
Foreign Lines Worked over	....	....	....	562¾	562¾
Total	1 834	1 794¾	39¼	2 494¾	2 481¼

STATEMENT OF TRAIN MILEAGE.

Passenger Trains	10 258 096	9 796 002
Goods and Mineral Trains	9 438 932	9 802 718
Total	19 697 028	19 598 720

THE BALTIMORE AND OHIO RAILROAD.

This railroad has been selected by the author as a sample of the extreme type of the American system of railroad construction. In this we have a trunk line doing a very large and profitable traffic, constructed in an engineering sense through an extremely difficult country, which obliged the adoption of very sharp curves and steep grades. (See Plate I.)

It is perfectly safe to say that the curves on this road could not be operated safely at any reasonable speed by rolling stock built on the English type, with long and rigid wheel-base; and to have built this road with easy curves, suitable for it, the cost would have been many times what it has; in fact the cost would have been so great, that, as a commercial undertaking, it would have been impracticable. The operating expenses of the Baltimore and Ohio Railroad show that engineers generally have over-estimated the expense of operating sharp curves. The experience of this road shows that with properly constructed rolling stock the expense is comparatively small, and it can be safely operated at high speed.

This road attains a maximum summit elevation of 2 620 feet above the sea, with very sharp curves, yet the total cost of all the coal used on the main stem and branches, aggregating 553 miles, only cost $339 239.73, in a total operating expense of $6 147 658.80, or 5.5 per cent. The annual cost of fuel for each mile of road is $613, which is 6 per cent. interest on $10 216. So if it had been possible to have located a road that would *have saved all the fuel*, the engineer would have been only justified in expending $10 216 per mile additional to accomplish it.

This road has a great many disadvantages to contend with, and no advantages except cheap fuel, which is probably about the same price as on the English roads.

The data about the Baltimore and Ohio Railroad from which these Tables have been constructed, have been taken from the Company's Annual Report for 1883, pages 30 and 44; the line operated embracing the main stem, including Winchester and Potomac, Winchester and Strasburg, Strasburg and Harrisonburg, Metropolitan Branch, Washington City and Point Lookout, and Somerset and Cambria branches, making a total of 553 miles.

By referring to Table 12, showing the annual operating expenses of the Baltimore and Ohio Railroad, the percentage of all the expenses that are affected by good or bad construction amounts to............	61.3
The English roads average..........................	51.8
Balance against Baltimore and Ohio, per cent........	9.5
Annual operating expenses of Baltimore and Ohio as per Table 12..................................	$6 147 666
Annual saving in the working expenses, if the road had been constructed equal to the average English roads, $6 147 666 × .095	584 028
Ditto per mile....................................	1 056
This annual saving per mile, capitalized at six per cent.	17 600

Thus it appears that the engineer would have been justified in spending $17 600 only additional, in making the road equal to the English standard of perfection. You can judge how far this would have gone in enlarging the many curves from 600 feet radii to a minimum of half a mile radii, to say nothing of the grade, and the summit elevation.

Mr. James L. Randolph, M. Am. Soc. C. E., Consulting Engineer of the Baltimore and Ohio Railroad, gives the author the following short description of the character of the line:

First Division.

Length of line.................................. 100 miles.

Baltimore (50′ A. M. T.) to Martinsburgh (415′ A. M. T.)

The road has no notes of the line between Baltimore and Harper's Ferry. The seven miles next to Baltimore, and the forty-three next to Martinsburgh, have curves and tangents about the same as the Second Division. The other fifty miles, in the valley of the Patapsco, has strong curves and few tangents, and is similar to the Third Division.

Second Division.

Length of line.................................. 100 miles.

Martinsburgh (415′ A. M. T.) to Piedmont (919′ A. M. T.)

Minimum radius of curves...............	1 000 feet.
Degrees turned...................	10 086 = 28 miles.
Total ascent westward..................	778 feet.
Total descent "	274 "
Maximum grade.......................	39.6 per mile.
Running time, including stoppages, 2 hours 35 minutes, = ...	38.7 miles per hour.

Third Division.

Length of line.................................... 73¾ miles.
Piedmont (919′ A. M. T.) to Grafton (987′ A. M. T.)
Minimum radius of curves................ 600 feet.
33¾ miles curved, and 5 miles of this less than 650 feet radius.
Degrees turned......................... 9 078.
Maximum grade on tangents............. 120 feet.
Maximum grade on curves of 650 feet radius............................ 114 feet per mile.
Total ascent westward.................. 2 402 "
Total descent " .... 2 334 "
Running time, including stoppages, 2 hours 38 minutes, = ... 29.3 miles per hour.

Fourth Division.

Length of line.................................... 99¼ miles.
Grafton (987′ A. M. T.) to Wheeling (645′ A. M. T.)
Minimum radius of curves.............. 600 feet.
Degrees turned........................ 14 976.
Length of curved line................. 59¼ miles.
" " straight " .... 40 "
Length of curvature less than 650 feet radius............................ 5½ "
Maximum grade per mile............... 80 feet.
Total ascent westward................. 779 "
Total descent " .... 1 121 "
Running time, including stoppages, 3 hours 14 minutes, = ... 30.8 miles per hour.
Elevation of summit above mean tide... 2 620 feet.

The Pennsylvania Railroad.

The officers of the Pennsylvania Railroad have kindly sent the author the data given below and that on Plate II. This railroad has justly become celebrated for its thorough management, cheap charges, both for freight and passengers, and the great attention paid to promoting the comfort of the latter.

As will be seen by the profile on Plate II, the road commences at tide level at Philadelphia, runs over an undulating country, crossing

the Blue Ridge at Gallitzin at an elevation of 2 154 feet above tide, terminating at Pittsburgh at 738 feet above tide.

PHILADELPHIA, August 11th, 1885.

Mr. EDWARD BATES DORSEY,
Consulting Engineer,
The American Exhibition,
7 Poultry, London, E. C., Eng.

MY DEAR SIR,—I am pleased to acknowledge receipt of your favor of August 1st, with inclosure. I am glad to know you have taken so warm an interest in the comparison of the various railways throughout the world. There is a great deal that may be said in favor of our American railways, but I think a great deal of criticism can be made against them.

I note what you say, especially in reference to the difference in the compensation which the railway companies receive from different classes of passenger travel. This is a question to which I have given some thought. I am well satisfied that in America what we call parlor or sleeping-car traffic does not pay anything like the returns which the railway companies receive from ordinary passenger travel.

Very truly yours,
G. B. ROBERTS,
President.

PHILADELPHIA, June 11th, 1885.

EDWARD BATES DORSEY, Esq.,
Member of American Soc. C. E.,
London, Eng.

DEAR SIR,—Answering your letter of the 23d ult., which only reached me on the 8th inst., I send you herewith a blue print showing the grade line of the Pennsylvania Railroad from Pittsburgh to Philadelphia.

We have no plan of the line of the road on a small scale from which we could get you a print.

Our curves are generally light, though we have three or four on the line as high as eight degrees, and quite a number of six degrees, but the majority are less than four degrees.

I am not able at the present time to give you the percentage of curvature, but it certainly does not vary much from 33 per cent.

We also inclose you a lithograph of the cross-section of our road-bed, which, I think, has nearly as much effect on the economical working of a railroad as the curvature. We have learned by experience that the cheapest way to operate a railroad is to keep the track in first-class condition at all times.

Respectfully,
WM. H. BROWN,
Chief Engineer.

Cost of Construction Compared.

From the preceding tables, it appears that the average cost of railways in

England, in 1883 was, per mile................	$202 227
In the United States "	62 176*
Excess in cost of the English................	$140 051

In England, the land or right of way, Parliamentary expenses, block system, and crossings, cost much more than in the United States, but this is more than balanced by the saving in the price of labor, iron and steel, which constitute most of the cost of railroad construction. These items probably averaged during the construction of the roads one-third cheaper in England than in the United States.

Owing to the high prices of land, high charges for right of way, Parliamentary expenses, the almost universal use of the block system of signals, and the bridges at road-crossings, the cost of construction of the English railroads must necessarily be greater than the American.

Referring to Table 6, it appears that the percentage of the total annual operating expenses that is affected by good or bad construction is 7.9 per cent. greater on the average of all the American railroads than on the average of all the English roads—say eight per cent.

Table 16 shows that the total operating expenses for all the railways of England in 1883 was, per mile, $10 000, and in the United States, for all the railroads it was, per mile, $4 410.

If all the railroads of the United States had been as well constructed as in England, that is, at an additional cost of $140 051 per mile, there would have been saved eight per cent. of the annual operating expenses, which averaged $4 410 per mile; eight per cent. of this amounts to $353, which would have been the amount saved by expending $140 051 more per mile; this equals 0.25 per cent. on the additional cost. In other words, it would have required an additional expenditure in construction of $140 051 per mile, to save annually $353 in working expenses.

On the other hand, if the English railroads had been built on the American plan, at $140 051 per mile less cost, their working expenses would have been increased eight per cent., or $800 per mile annually. To save this, $140 051 has been expended per mile.

* Probably over one-third of this cost is made by inflated or watered stock. If all our railroads had been built as the English built theirs, where all the stock and bonds are sold at or near par, and nearly all the proceeds applied fairly and squarely to the construction or improvement of the roads, the average cost would not be over $40 000 per mile.

Poor's Manual for 1883, which is the best authority on the cost and working of the American railroads, at page iv says: "The actual cost of all the railways in the United States does not exceed $3 787 410 728; this divided by 121 592 miles = $31 148 average cost per mile."

OPERATING EXPENSES OF ENGLISH AND AMERICAN RAILROADS COMPARED.

Explanations.

In order to compare the cost of operating the two systems of railroads, and to ascertain if the greater cost of constructing the English roads gave a corresponding saving in working expenses, Tables Nos. 23, 24, 25 and 26 were computed. The data for the English roads were taken from their semi-annual reports and from the reports of the Board of Trade. Those for the American roads were taken from the reports of the Railroad Commissioners of the States of New York and Massachusetts, and in some cases from the reports of the companies, and in all cases can be considered reliable. In some cases it has been necessary to exercise discretion in analysing the accounts, as different companies have different forms for keeping their books. The railroads of the United Kingdom selected for comparison embrace all the leading roads. The American railroads selected are all located in a country naturally as rough and offering as great, if not greater, physical obstacles to cheap working than that in which the English roads are located. All roads or branches located in level or prairie country have been excluded.

The American roads selected have certainly no advantage in the physical character of the country they pass through.

In order to make the comparison more complete, the selected American roads embrace all kinds of roads, from the large trunk lines down to the small provincial or local roads. All, however, show very uniform workings.

Ton and Passenger Mileage per Mile of Single Track.

Many prominent railroad men in England have told the author that it is necessary to run the freight trains at great speed in order to clear the track of their enormous business. In order to compare the traffic on the different roads, and to ascertain the force of this assertion, Table No. 24 was constructed, showing the analyses of the traffic of the principal railroads of each country. In this table all the tracks have been reduced to single track, and the ton and passenger mileage calculated upon this basis.

In all returns made by the English railroads, no mention is made of

third or fourth tracks, they being included under the general head of "double or more tracks."*

All the large companies of England have many miles of third and fourth tracks. For the want of reliable data these have not been calculated in their mileage; if these were added, their single track mileage would be largely increased, and, consequently, the traffic per mile would be proportionally reduced.

On the American railroads all tracks have been estimated and included in the single track.

In both countries all sidings and turnouts have been excluded.

The following recapitulation of Table No. 24 embraces the railroads having the most traffic.

TABLE No. 22.

Name of Railroad.	Mileage per Mile of Single Track.	
	Passenger.	Ton.
England.		
North Eastern	137 000	455 138
Midland	181 272	512 714
London and North Western	233 777	473 912
London, Chatham and Dover	634 036	195 906
London, Brighton and South Coast	547 328	192 778
Great Western	190 111	308 703
Average	320 587	356 525
United States.		
Boston and Albany	272 642	609 686
Boston and Providence	492 863	194 772
New York, New Haven and Hartford	516 694	314 359
New York Central and Hudson River	182 680	927 973
New York, Lake Erie and Western	114 982	1 216 913
Pennsylvania—Pennsylvania Railroad Division	130 235	1 594 898
Average	285 016	809 767

* The returns of the Board of Trade for 1883, in their Table No. 2A, gives the third and fourth track on some of the English railroads. Apparently in some cases sidings are included in this list. In order to be on the safe side, these additions have not been included in the estimate of single-track mileage; by including them, the single track stated in this paper would be increased as follows, viz.:

London and North Western	256 miles.	Great Northern	82 miles.
London and South Western	20 "	London, Brighton and South Coast	28 "
Midland	162 "	Great Western	38 "

From this it appears that the above six American railroads average more than double freight, with only eleven per cent. less passenger traffic than the six English.

The Pennsylvania ton mileage is more than three times that of the Midland, the highest ton mileage on the English list, while their passenger mileage is only 29 per cent. less.

The Boston, New Haven and Hartford in passenger traffic is 19 per cent. less than the London, Chatham and Dover, the highest on the English list, while their freight is 60 per cent. more.

The Boston and Albany has a larger passenger and freight traffic than any of the large or trunk lines of England.

From this showing, it does not appear necessary to run the trains on the English roads any faster in order to clear the tracks of traffic than on the American railroads.

Cost of Fuel.

The management of the railroads of the United Kingdom kindly furnished the author with the cost of coal used on their respective lines. For this information and other courtesies received from them, the author takes this opportunity to return his thanks. As this information was furnished confidentially, he does not feel justified in giving the exact figures. As a compromise, he has assumed the cost of coal on the lines north and west of London running into the coal-fields at 6s. 8d., or $1.60, per ton of 2 240 lbs., and on most of the roads south of London at 12s. 6d., or $3. In most cases this is somewhat higher than the actual prices given, in some few instances slightly lower, but in all cases sufficiently accurate for comparison. The price given is the cost of coal delivered to the roads, and does not include any charge for transportation on the road consuming it.

The cost of coal on the American railroads running into coal-fields has been taken as the same as on the English railroads running into coal-fields. *i. e.*, $1.60 per ton of 2 240 lbs.

The cost of coal consumed on the New York Central and Hudson River Railroad could not be ascertained from any official source. All through this paper it has been estimated as costing $3.20 per ton of 2 240 lbs.

Wages of Engine-Drivers and Firemen.

After careful inquiry, the average daily wages of the English engine-driver has been taken at 7s. = $1.68, and the American at $3.83. And

that of the English fireman at 4s. = $0.96, and the American at $1.99. To equalize these, the American wages should be reduced 54.6 per cent., but in order to be safe, they have only been reduced 50 per cent.

Repairs and Renewals of Locomotives.

The result as shown by this column in Table No. 23 was a great surprise to the author. He had the impression that the English locomotive on their smooth roads would require less repairs than the apparently weaker American locomotive on our rougher roads, some of which are far from being equal to the English standard.

The average cost of repairs and renewals of locomotives on fourteen railroads in the United Kingdom was 7.8 per cent. of the total operating expenses, against 5.7 per cent., the average of eight American railroads, or say, one-third less.

This is very strong and emphatic contradiction to the often repeated assertion, that the outside-cylinder engines will shake and twist themselves to pieces. A few days since, a prominent railroad man in England told the author that he had thoroughly tried the outside-cylinder engines, but had given them up on account of the great expense of repairs, "that they wriggled themselves to pieces."

As labor constitutes about one-half the cost of locomotive repairs, the wages paid in the United States should be reduced 50 per cent. to equalize them with those paid in England; the average percentage of the cost of repairs and renewals on the American railroads would then be 4.3 per cent. of the total operating expenses, against 7.8 per cent. on the railroads of the United Kingdom, or nearly one-half.

Maintenance of Way.

The average cost on fourteen English railways was 17.8 per cent. of the total operating expenses, while the average on eight American roads was 21.6 per cent., say 4 per cent. more. This apparently should be much larger when we consider the great amount of perishable materials that enter into our construction, the higher wages to our workmen, and our severe winter weather.

Passenger Cars.—Repairs and Renewals.

The cost of repairs and renewals of passenger cars is about the same in the two countries, the average on the English roads for 1 000 pas-

senger miles being $1.27, and on the American $1.34. As 86 per cent. of the travel in the United Kingdom is third class—on the carriages for this no attempt at ornament, finish or comfort is ever made, they being generally little better than our box cars, with cheap seats and cushions—the first cost and repairs should be very small, much less than on ours. This will make the repairs and renewals of the first-class carriages very large, probably over three times what ours cost. This is another argument in favor of the author's previous assertion, that first-class travel, as now conducted on the English railroads, does not pay.

Freight Cars.—Repairs and Renewals.

But little information can be derived from this comparison, owing to no distinction being made in the reports of the tonnage transported in the companies' cars, or in the cars of firms, or cars of outside companies. This makes the cost of repairs and renewals appear very small on trunk lines, and greater on small lines that run their own cars. As over 90 per cent. of the English freight cars are either coal or open flat cars, their cost of repairs and renewals may be less than ours.

Cost of General Management.

This is about the same in both countries, varying from one to two per cent.—averaging two per cent. of the total operating expenses.

Cost of Motive Power.

The author was very much astonished at the motive power costing nearly double on the English railroads what it does on the American, as shown by Table 23. He expected it would be much greater on the latter, owing to their inferior construction and alignment. In fact this comparison, showing the cost of motive power, was commenced to show the American engineer the economy in operating railroads with good road beds, etc., such as the English have, over the generally inferior constructed roads of the United States. To ascertain if this was not a singular coincidence in one year's business, Table No. 26 was constructed, which shows on five of the principal railroads of each country, for the years 1882, 1883 and 1884, the average annual total operating expenses, cost of fuel, cost of labor on motive power, and the cost of repairs and renewals of locomotives.

TABLE No. 25.

Analysis of Train Service, etc., on the Principal Railroads of the United Kingdom and of the United States.

United Kingdom, 1883.	Total Length of Lines Operated. Miles.	All reduced to Single Track. Miles.	Passenger Train Mileage.		Passenger Mileage.		Freight Train Mileage.		Ton Mileage.		Total Freight and Passenger Train Mileage per Mile of Single Track.
			Total.	Per Mile of Single Track.	Total.	Average per Train-Mile.	Total.	Per Mile of Single Track.	Total.	Average per Train-Mile.	
Great Northern	768	1 372	8 091 256	5 890	286 512 050	35.4	8 238 177	6 005	502 973 520	61.5	11 895
North Eastern	1 534	2 548	9 681 906	3 800	359 184 052	37.1	14 763 232	5 798	1 159 691 280	78.5	9 598
Midland	1 381	2 384	13 105 400	5 493	432 151 874	32.9	19 981 855	8 382	1 222 309 920	61.0	13 875
London and North Western	1 793	3 190	18 931 111	5 935	745 749 134	39.4	19 395 461	6 080	1 511 779 440	78.0	12 015
Great Western	2 268	3 377	14 298 157	4 234	642 025 920	44 9	16 047 939	4 752	1 042 489 200	65.0	8 986
Great Eastern	1 049	1 599	8 486 358	5 307	386 454 286	45.5	5 334 027	3 336	369 094 320	69.2	8 643
South Eastern	370	699	4 930 330	7 053	326 660 480	66.3	1 416 949	2 027	121 009 920	85.4	9 080
London, Chatham and Dover	160	309	3 152 677	10 202	195 917 102	62.2	678 173	2 195	60 534 960	89.5	12 397
Caledonian	877	1 339	5 232 096	3 908	195 721 238	37.4	6 617 610	4 942	456 161 700	68.9	8 850
Glasgow and South Western	332	571	2 230 838	3 907	92 966 400	41.7	2 294 680	4 020	154 419 120	67.0	7 927
North British	1 006	1 419	5 032 790	3 547	193 726 340	38.5	6 428 496	4 537	396 243 120	61.3	8 084
Great Southern and Western of Ireland	478	673	1 678 691	2 494	66 844 142	39.8	1 164 993	1 730	86 676 000	74.4	4 224
London, Brighton and South Coast	403	676	6 521 451	9 648	369 993 492	56.7	1 427 306	2 111	130 318 080	91.0	11 759
London and South Western	721	1 222	8 001 548	6 548	406 375 606	50.8	3 045 365	2 492	216 649 920	71.0	9 040
United States, 1884.											
Boston and Albany	384	614	1 949 970	3 176	167 402 441	85.9	3 010 215	4 903	374 347 455	124.3	8 079
Boston and Lowell	550	590	1 305 150	2 212	61 343 056	47.0	610 162	1 031	59 427 991	97.4	3 243
Boston and Maine	204	271	1 289 545	4 759	89 587 566	69.5	540 028	1 993	44 937 544	83.2	6 752
Boston and Providence	68	112	727 348	6 494	55 200 708	76.0	246 298	2 200	21 814 443	88.6	8 694
Old Colony	468	525	1 629 344	3 104	116 745 901	71.6	799 610	1 523	57 899 872	72.4	4 627
New York, New Haven and Hartford	265	400	2 365 746	5 914	206 677 775	87.3	1 461 939	3 655	125 743 803	86.0	9 569
New York, Lake Erie and Western	1 029	1 475	3 791 414	2 571	169 599 245	44.8	7 513 873	5 098	1 794 946 519	239.0	7 669
New York Central and Hudson River	993	2 123	6 425 258	3 027	387 829 886	60.4	10 027 577	4 700	1 970 087 115	196.5	7 727
Pennsylvania—Pennsylvania Division	1 358	1 879	5 775 873	3 074	243 298 222	42.1	15 015 905	8 000	3 082 499 986	205.0	11 074
Pennsylvania—United Railroads of New Jersey Division	443	576	4 168 381	7 237	248 789 706	60.0	4 240 545	7 362	552 423 171	130.0	14 599

TABLE No. 26.

Comparison of the Average Annual Cost of Motive Power on Five of the Principal Railroads of England and the United States, for the Years 1882, 1883 and 1884.

Name of Railroad.	Total Operating Expenses, less Steamboat Expenses, Taxes and Duties.	Fuel. Amount actually Paid.	Fuel. Percentage on Operating Expenses. Amount actually Paid	Fuel. Percentage on Operating Expenses. All reduced to English prices ($1.60 per ton of 2 240 pounds).	Wages of Engine-drivers and Firemen. Amount Paid.	Wages. Percentage on Operating Expenses. Amount actually Paid.	Wages. Percentage on Operating Expenses. All reduced 50 per cent. to English Prices.	Repairs and Renewals of Locomotives. Amount actually Paid.	Repairs. Percentage on Operating Expenses. Amount actually Paid.	Repairs. Percentage on Operating Expenses. One-half of Cost of Repairs being Labor, which is here reduced 50 % to equalize it with the English.	Total percentage of Fuel; wages of Engine-drivers & Firemen; and Repairs and Renewals of Locomotives to Operating Expenses. Amount actually Paid.	Total percentage. All reduced to English Prices.
England.												
a Great Northern	£1 998 954	£132 495	6.6	6.6	£177 270	8.9	8.9	£135 734	6.8	6.8	22.3	22.3
a North Eastern	3 253 949	219 879	6.8	6.8	317 567	9.8	9.8	405 114	12.5	12.5	29.1	29.1
a Midland	3 607 350	227 303	6.3	6.3	425 629	11.8	11.8	351 702	9.8	9.8	27.9	27.9
a London and North Western	4 845 722	271 191	5.6	5.6	453 566	9.4	9.4	364 411	7.5	7.5	22.5	22.5
a c Great Western (2⅛ years)	3 512 520	195 945	5.6	5.6	315 892	9.0	9.0	372 298	10.6	10.6	25.2	25.2
Average	....	....	6.2	....	....	9.8	9.8	....	9.4	9.4	25.0	25.0
United States.												
b Boston and Albany	$5 353 344	$702 442	13.1	4.2	$406 688	7.4	3.7	$417 792	7.8	5.9	28.3	13.8
b New York, New Haven and Har.	4 205 166	429 977	10.2	4.2	252 301	6.0	3.0	152 469	3.6	2.7	19.8	9.9
b New York, Lake Erie and W.	13 248 239	1 370 670	10.3	6.9	1 114 471	8.4	4.2	632 474	4.8	3.6	23.5	14.5
b New York Central and H. R.	18 345 765	2 224 221	12.1	6.0	1 356 155	7.4	3.7	1 028 562	5.6	4.2	25.1	14.3
a Penn. R. R.—Penn. R. R. Div.	17 383 519	1 109 874	6.4	6.4	1 237 749	7.1	3.5	1 479 675	8.5	6.4	22.0	16.3
Average	....	....	10.4	5.5	....	7.3	3.6	....	6.1	4.6	23.7	13.8

a This data taken from reports of the company.
b This data taken from report of the Railroad Commissioners of New York and Massachusetts.
c Returns for the six months ending June 30th, 1884, could not be obtained, consequently they are omitted.
All charges for steamboat expenses have been deducted from the operating expenses.

The English roads were selected as being five of the roads doing the heaviest and largest traffic in the United Kingdom. The American five roads were selected from the Eastern system of roads, with the exception of the New York, New Haven and Hartford, built through a country more broken physically than that in which the English roads are located.

From this table, it appears that the greater cost in motive power of operating the English over the American railroads, as shown by Table 23, is not an accidental coincidence of one year, but is fully sustained by three years' working on five of the principal railroads in each country.

Supposing that the longer ton and passenger haulage of the above American lines influenced the result in their favor, the same calculation on the same basis, except the taxes are included in operating expenses, has been made for 1884, on the following short railroads of Massachusetts, where the average haulage is very short.

TABLE No. 27.

Name of Railroad.	Percentage on Operating Expenses, all Reduced to the Price Paid in England.			
	Coal.	Wages.	Repairs and Renewals of Locomotives.	Total.
Boston and Lowell	4.2	3.7	4.7	12.6
Boston and Maine	4.0	3.3	4.2	11.5
Boston and Providence	3.1	3.5	5.0	11.6
Old Colony	3.3	3.7	3.6	10.6
Average	3.6	3.6	4.4	11.6

The results of the workings of these small and short railroads are still more favorable to the American system.

As an additional check upon the cost of motive power on the American railroads, Table No. 28 was compiled. This contains an analysis of the cost of motive power on sixteen of the principal railroads of Massachusetts for the years 1883 and 1884. This table fully confirms the previous deductions, though this is hardly fair to the American railroads, as most of the roads in this table operate short lines and do small business,

consequently they cannot afford to keep up an efficient staff and have such thorough management as the large railroads of America or England. Moreover, as their consumption is small, they cannot buy their coal and other supplies on such advantageous terms as the larger consumers.

Cost per Train Mile.

In order to meet the views of those accustomed to compare the cost of train miles, Table No. 29 was made. The English make no separate return of the cost of motive power in freight and passenger traffic, so, for this table it was necessary to add the two together and take the aggregate train mileage. In consequence of the size of the trains varying so much in the two countries; the variation between different roads of the proportion between passenger and freight trains, which makes a proportionate variation in the cost of operating; and the absence of all official data from the English roads regarding their ton and passenger mileage; these deficiencies, in the opinion of the author, make this table less reliable than the previous ones, where the cost of motive power and other expenses were compared, by taking their percentage to the total operating expenses; for in roads constructed in similar countries, the different items of operating expenses should bear a close proportionate percentage to each other.

In order to be safe beyond all question, the Massachusetts railroads have been largely used for comparison. These have no advantage whatever over the English roads, being with one exception all short lines with short haulage, located in a rough and broken country. In every respect they are more unfavorably situated for cheap working than the average of the English roads. Moreover, the Reports of the Railroad Commissioners of Massachusetts are as reliable as those of the English Board of Trade, and much more thorough and complete—these give very reliable data for comparison.

In the repairs of locomotives, in the English cost there has been included nothing except the actual material and labor used in the repairs, while in the American cost is included superintendence, cost and repairs of tools, shop, etc. This would make the difference in the cost still greater if these items were added to the English cost.

In Table No. 29, after reducing the cost down to the English standard of prices, the average of six American railroads cost in motive power

Years 1883 and 1884.

	…rivers …	Repairs and Renewals of Locomotives.			Percentage of Cost of Fuel, Wages of Engine-drivers and Firemen, and Repairs and Renewals of Locomotives on Total Operating Expenses.		Dividends Earned. Per Cent.
	…age on …ting …nses.		Percentage on Operating Expenses.				
	Reduced 50 % to Equalize with English Prices.	Total Amount Paid.	Amount Paid.	Reduced 25 % to Equalize Wages with English.	Amount Actually Paid.	All Reduced to the English Standard of Prices.	
Boston and Albany, 1…	....	$434 726	....	....	....	....	8.2
" 1…	....	391 757	....	....	....	....	8.1
" a…	3.7	413 242	7.6	5.7	28.3	13.8	....
Fitchburg, 1883.....	....	125 710	....	....	....	....	6.4
" 1884.....	....	133 792	....	....	....	....	5.4
" average..	4.5	129 751	6.4	4.8	30.4	14.3	....
Boston and Lowell, 18…	....	90 183	....	....	....	....	6.5
" 18…	....	128 354	....	....	....	....	5.7
" av…	3.9	109 269	6.4	4.8	27.9	13.1	....
Boston and Maine, 18…	....	106 743	....	....	....	....	8.2
" 18…	....	116 698	....	....	....	....	8.2
" av…	3.4	111 721	5.7	4.3	24.9	11.9	....
Eastern, 1883........	....	202 854	....	....	....	....	4.0
" 1884........	....	174 921	....	....	....	....	3.8
" average	3.7	188 888	8.4	6.3	28.8	14.5	...
Boston and Providen…	....	84 568	....	....	....	....	8.2
"	....	82 674	....	....	....	....	8.2
"	3.7	83 621	6.7	5.0	23.8	12.1	....
Old Colony, 1883....	....	194 193	....	....	....	....	6.0
" 1834....	....	142 436	....	....	....	....	7.0
" average.	3.7	168 315	5.8	4.3	23.3	11.4	....
Providence and Worc…	....	29 680	....	....	....	....	8.5
"	....	59 204	....	....	....	....	6.8
"	3.5	44 442	5.5	4.1	21.8	10.6	....
New Haven and Nort…	....	47 717	....	....	....	....	Nil.
"	....	35 245	....	....	....	....	Nil.
"	3.0	41 481	7.5	5.6	25.5	13.1	....
New London Norther…	....	69 329	....	....	....	....	6.0
"	....	18 675	....	....	....	....	6.0
"	3.6	44 002	11.3	8.5	35.1	17.9	....
New York and New E…	....	332 086	....	....	....	....	Nil.
"	....	331 141	....	....	....	....	Nil.
"	3.9	331 614	11.4	8.6	34.4	19.1	....
Cheshire, 1883	....	27 367	....	....	....	....	2.8
" 1884........	....	30 574	....	....	....	....	3.5
" average.....	4.0	28 970	6 9	5.2	38.8	15.4	....
Connecticut River, 18…	....	30 209	....	....	....	....	9.5
" 18…	....	33 906	....	....	....	....	9.1
" av…	3.6	32 058	5.6	4.2	28.5	12.1	....
Norwich and Worceste…	....	29 425	....	....	....	....	8.6
"	....	28 030	....	....	....	....	8.1
"	4.2	28 728	6.6	5.0	27.6	13.6	....
Worcester, Nashua an…	....	41 432	....	....	....	....	3.3
"	....	39 105	....	....	....	....	2.6
"	3.3	40 269	8.8	6.6	33.0	15.1	....
New York, New Haven…	....	152 469	....	....	....	....	10.2
" "	....	152 469	....	....	....	....	10.1
Average of three years…	3.0	152 469	3.6	2.7	19.8	9.9	....
Total........	....	3 897 672	....	....	....	....	....
Average—16 Massachu…	3.7	....	6.9	5.2	27.1	13.3	....
" 14 Railroads… Table 23…	8.6	....	7.8	7.8	23.6	23.6	....

$0.021, or 14 per cent. less per train mile than the average cost of six English railroads, notwithstanding that the average load of the American train was more than double in tons, and over 50 per cent. more in passengers. This corresponds very closely with the result obtained by calculating upon the percentage basis.

The London and North Western, of England, and the Boston and Albany, of the United States, have each about double the ton mileage to that of their passenger mileage, consequently they offer a good basis for comparison. The motive power (the prices being reduced to the English rates) costs the same per train mile. The American road, however, averaged 60 per cent. more load on their freight trains, and more than double the load on their passenger trains.

The London and North Western Railway had in 1883 a total passenger train mileage of 18 931 111. Supposing that they carried the same average load as the Boston and Albany did in 1884, *i. e.*, 85.9, this will give a total passenger mileage of $18\ 931\ 111 \times 85.9 = 1\ 626\ 182\ 435$. The total receipts from all classes of passengers were £3 355 142 ; dividing the total passenger mileage as above into this, gives .495d. as the average fare per mile paid by each passenger, first, second and third-class included.

In 1883 the London and North Western Railway ran 19 395 461 freight train miles. Supposing that they transported the same average load as the Boston and Albany did in 1884, *i. e.*, 124.3 tons, this will give a total ton mileage of $19\ 395\ 461 \times 124.3 = 2\ 410\ 855\ 802$; dividing this into £6 299 081, the total amount received from freight traffic, gives .627d. as the average price paid per ton per mile.

These equated prices are less than one-half of the actual or ruling prices.*

The Great Eastern, of England, and the Boston and Lowell, of the United States, also offer a good basis for comparison, as each have about equal passenger mileage to their ton mileage. Reducing all to the English standard of prices, the American road is operated at $0.026, or 19 per cent. less cost per train mile than the English, while the freight load of the American train is 40 per cent. larger and the passenger load five per cent. greater.

* The present freight charge by the London and North Western Railway from Manchester to Liverpool, 29 miles, is 9s. 2d. or $2.20 per ton of 2 240 pounds for goods in bales and cases, being about 7.6 cents per ton per mile.

TABLE No. 29.

Cost of Motive Power per Train Mile on Six English and Six American Railroads.

NAME OF RAILROAD.	TOTAL MILEAGE.			AVERAGE LOAD OF TRAIN.		AVERAGE MILEAGE.	
	Train. Passenger and Freight.	Passenger. (For English Railroads calculated as stated on page 17.)	Ton. (For English Railroads calculated as stated on page 16.)	Passenger. Number of Passengers Per Mile of Passenger Train.	Freight. Number of Tons Per Mile of Freight Trains.	Passenger.	Ton.
ENGLAND, 1883.							
Great Northern	16 329 433	288 069 860	502 973 520	35.6	61.5	....	53
North Eastern	24 445 138	363 647 121	1 159 691 280	37.6	78.5	....	29
Midland	33 087 255	436 338 084	1 222 309 920	33.3	61.	....	48
London and North Western	38 326 572	744 151 164	1 511 779 440	39.3	78.	....	42
Great Western	30 346 096	642 205 320	1 042 489 200	44.9	65.	....	43
Great Eastern	13 820 385	382 764 707	369 094 320	45.1	69.2	....	52
Average	....	....	....	39.3	68.9	....	44.5
UNITED STATES, 1884.							
Boston and Albany	4 960 185	167 402 441	374 347 455	85.9	124.3	....	112
New York, New Haven and Hartford	3 827 685	206 677 775	125 743 803	87.3	86.	....	58
New York, Lake Erie and Western	11 305 287	169 599 245	1 794 946 519	44.8	239.	....	162
New York Central and Hudson River	16 452 835	387 829 886	1 970 087 115	60.4	196.5	....	193
Pennsylvania—Pennsylvania Railroad Division	20 791 778	244 710 876	2 996 892 567	42.2	205.	....	134
Boston and Lowell	1 915 312	61 343 056	59 427 991	47.	97.4	....	40
Average	....	....	....	61.3	158.	....	116.5

TABLE No. 29.—*Continued.*

NAME OF RAILROAD.	FUEL.			WAGES OF ENGINE-DRIVERS AND FIREMEN.			REPAIRS AND RENEWALS OF LOCOMOTIVES.			COST OF FUEL, WAGES OF ENGINE-DRIVERS AND FIREMEN, AND REPAIRS AND RENEWALS OF LOCOMOTIVES, PER TRAIN MILE.	
	AMOUNT ACTUALLY PAID.		Per Train Mile. Coal reduced to $1.60 per ton of 2 240 lbs.	AMOUNT ACTUALLY PAID.		Per Train Mile. All American Wages Reduced 50 Per Cent. to Equalize Them with English Wages.	AMOUNT ACTUALLY PAID.		Per Train Mile. All American Wages Reduced 50 Per Cent. to Equalize Them with English Prices.	Amount Actually Paid.	All Reduced to English Prices.
	Total.	Per Train Mile.		Total.	Per Train Mile.		Total.	Per Train Mile.			
ENGLAND, 1883.											
Great Northern	$699 965	$0.043	$0.043	$903 050	$0.055	$0.055	$680 635	$0.042	$0.042	$0.140	$0.140
North Eastern	1 150 780	.047	.047	1 640 655	.067	.067	1 994 480	.082	.082	.196	.196
Midland	1 167 305	.035	.035	2 153 220	.065	.065	1 803 705	.054	.054	.154	.154
London and North Western	1 386 283	.036	.036	2 295 860	.060	.060	1 839 260	.048	.048	.144	.144
Great Western	1 017 880	.034	.034	1 584 205	.052	.052	1 855 190	.061	.061	.147	.147
Great Eastern	793 935	.057	.040	818 870	.060	.060	765 990	.056	.056	.173	.162
Average	....	$0.042	$0.040	....	$0.060	$0.060	....	$0.057	$0.057	$0.159	$0.157
UNITED STATES, 1884.											
Boston and Albany	$659 592	$0.133	$0.048	$402 376	$0.081	$0.041	$391 757	$00.079	$0.059	$0.293	$0.148
New York, New Haven and Hartford	450 436	.118	.045	259 758	.068	.034	155 425	.040	.030	.190	.109
New York, Lake Erie and Western	1 242 989	.110	.078	1 019 438	.090	.045	491 902	.044	.033	.244	.151
New York Central and Hudson River	1 956 397	.119	.060	1 338 142	.081	.040	865 184	.058	.040	.253	.140
Pennsylvania—Pennsylvania Railroad Division	1 094 534	.053	.053	1 257 956	.060	.030	1 497 444	.072	.054	.185	.137
Boston and Lowell	263 490	.138	.046	153 967	.080	.040	128 354	.067	.050	.285	.136
Average	....	$0.112	$0.054	....	$0.077	$0.038	....	$0.059	$0.044	$0.242	$0.136

In Tables 30 and 31, this method of calculation has been carried out more fully. In these tables can be seen at a glance what would have been the average receipts from each ton or passenger transported one mile, provided the train load had been the same as that carried by the American railroad with which it is compared. To facilitate comparison, the cost of motive power per train mile has been transferred from Table No. 29.

These equated prices are, without exception, much too low, averaging less than half the ruling or present prices. They are so much too small, that any argument based upon them would be absurd.

They show conclusively, that notwithstanding the average train mile costs in motive power less on the American railroads than on the English, yet the American average train load is much greater both in tonnage and passengers.

In order to make the comparison still more comprehensive, Table No. 32 was made. In this all the railroads of Massachusetts, 32 in number, embracing 2 852 miles of operated lines, are compared with all the railroads of England and Wales, embracing 13 340 miles of operated lines. Both systems for the years 1879 to 1884 inclusive, or for six years.

For want of time, the author has not been able to ascertain officially from each railroad included in Table 32, the exact cost of coal consumed. From data given in the previous tables it would be perfectly safe, in his judgment, to estimate the cost of coal consumed on the Massachusetts railroads at three times the price per ton of that consumed on the English and Welsh railroads; but, in order to be conservative, he has only estimated it at double cost. Nearly all the coal consumed on the Massachusetts railroads must be transported over 200 miles by rail or 400 miles by water; with but few exceptions, all the principal railroads of England and Wales run direct into the coal districts. A thorough calculation, based upon the actual prices paid by each railroad, would show the operating expenses of the Massachusetts railroad on the cost of fuel alone to be at least sixteen per cent., or two cents less per train mile than those shown in Table No. 32.

Table No. 32 shows that the average load of passenger trains per passenger train mile in Massachusetts in 1884, was 67 passengers.

In England and Wales in 1884, the total passenger-train mileage was 121 582 978 miles. Suppose that these averaged the same load as the Massachusetts trains did, this will give 121 582 978 $\times$ 67 = 8 146 905 526

TABLE No. 30.

Showing what would have been the Receipts from each Passenger per Mile Transported, First, Second and Third-class included, on the six English Railroads named in Table No. 28, if the Train Load had been the same as that of the American Railroads named in that table.

	Average Load of Passenger Trains. Number of Passengers.	Great Northern.	North Eastern.	Midland.	London and North Western.	Great Western.	Great Eastern.	Cost of Motive Power Per Train Mile. All reduced to English Prices.
Total Passenger Train Mileage	....	8 091 256	9 681 906	13 105 400	18 931 111	14 298 157	8 486 358	......
Total Receipts from Passengers	....	£1 230 963	£1 602 120	£1 904 275	£3 355 142	£2 963 292	£1 589 875	......
Boston and Albany	85.9	.43d.	.46d.	.41d.	.56d.	.58d.	.52d.	$0.148
New York, New Haven and Hartford	87.3	.42d.	.45d.	.40d.	.49d.	.57d.	.51d.	0.109
New York, Lake Erie and Western	44.8	.81d.	.88d.	.78d.	.95d.	1.11d.	1.00d.	0.151
New York Central and Hudson River	60.4	.60d.	.66d.	.58d.	.70d.	.82d.	.74d.	0.140
Pennsylvania—Pennsylvania Railroad Division	42.2	.86d.	.93d.	.82d.	1.08d.	1.19d.	1.04d.	0.137
Boston and Lowell	47.	.78d.	.85d.	.75d.	.90d.	1.06d.	.95d.	0.136
Cost of Motive Power per Train Mile	....	$0.140	$0.196	$0.154	$0.144	$0.147	$0.162	......

TABLE No. 31.

Showing what would have been the Receipts from each Ton Transported one Mile on the Six English Railroads named in Table No. 29, if the Train Load had been the same as that of the American Railroads named in that Table.

	Average Load of Freight Train. Number of Tons.	Great Northern.	North Eastern.	Midland.	London and North Western.	Great Western.	Great Eastern.	Cost of Motive Power per Train Mile. All Reduced to English Prices.
Total Freight Train Mileage	......	8 238 177	14 763 232	19 981 855	19 896 461	16 047 939	5 334 027	......
Total Receipts from Freight	......	£2 095 723	£4 832 047	£5 092 958	£6 299 081	£4 343 705	£1 537 593	......
Boston and Albany	124.3	.49d.	.63d.	.49d.	.63d.	.52d.	.55d.	$0.148
New York, New Haven and Hartford	86.	.71d.	.91d.	.71d.	.91d.	.76d.	.80d.	0.109
New York, Lake Erie and Western	239.	.26d.	.33d.	.26d.	.33d.	.27d.	.29d.	0.151
New York Central and Hudson River	196.5	.31d.	.40d.	.31d.	.40d.	.33d.	.35d.	0.140
Pennsylvania—Pennsylvania Railroad Division	205.	.29d.	.38d.	.29d.	.38d.	.32d.	.33d.	0.137
Boston and Lowell	97.4	.63d.	.81d.	.58d.	.80d.	.66d.	.68d.	0.136
Cost of Motive Power per Train Mile	......	$0.140	$0.196	$0.154	$0.144	$0.147	$0.162	......

passenger miles. The total receipts in 1884 from all classes of passengers on the railroads of England and Wales was £22 247 095; dividing this by their total passenger mileage gives .655d. as the average charge per mile traveled by first, second and third-class.

In England and Wales in 1884, the total freight-train mileage was 106 605 484. Supposing that they averaged the same load as the Massachusetts trains did, *i. e.*, 109 tons, this gives $106\,605\,484 \times 109 = 11\,619\,997\,756$ total ton mileage. The total receipts from freight in 1884 by the English and Welsh railroads was £31 973 111; dividing this by the total ton mileage gives .660d. as the average charge per ton per mile.

These equated charges, when taken together for freight and passenger traffic, are so much below the real prices, being less than half, that no arguments can be based upon them.

Even supposing the average train-loads to be equal in both countries, still the motive power on the English and Welsh railroads costs, on the average, twenty-five per cent. more than on the Massachusetts railroads per train mile, as shown by Table No. 32, notwithstanding the underestimate of the cost of coal consumed.

Locomotive Mileage.

The locomotive with compound engines, as perfected by Mr. F. W. Webb, has given very satisfactory results, and is being largely introduced on the London and North Western Railway.

Mr. Webb kindly furnished the author with the data given in Table No. 33.

"As regards the loads hauled, we may mention that the average train taken between Crewe and Euston by the 'Dreadnought' class, consists of twelve vehicles. On the 19th of March last, the 'Dreadnought' worked the 10 A. M. Scotch express from Euston to Carlisle, a continuous run of 300¼ miles, with an average load, including engine and tender, of 207 tons. On this journey the consumption of fuel averaged 29.2 pounds per mile, and the evaporation of water was 9.49 pounds per pound of coal. The train arrived at Rugby two minutes before time, left four minutes late, and arrived at Carlisle four minutes before time, the Shap incline—5½ miles of 1 in 75—being mounted in ten minutes, and the average running speed over the whole trip being 44.7 miles per hour. Neither the smoke-box or ash-pan was cleared out during the journey, nor was the fire cleaned. The engine steamed freely throughout the run, and the weight of ashes in the smoke box on the arrival at Carlisle was 40¼ pounds, and in the ash-pan 59½ pounds. These are certainly most admirable results.

"On March 27th last, also, engine No. 504, 'Thunderer,' worked

TABLE No. 32.

Average Cost per Train Mile for Motive Power on the Aggregate Railroads of England and Wales, and of the State of Massachusetts, for the Years 1879, 1880, 1881, 1882, 1883 and 1884.

Year.		Total Length of Lines Operated. Miles.	Average Miles each Passenger was Transported	Average Miles each Ton was Transported.	Total Train Mileage.	Average Train Load. Passengers.	Average Train Load. Tons.	Fuel.	Wages of Engine-drivers and Firemen.	Repairs and Renewals of Locomotives.	Total Average. Pence.	Total Average. Dollars.
1879	England and Wales..........	......	......	......	......	......	......	*b*	*b*	*b*	8.40	0.1680
"	Massachusetts.............	2 626	16	56	22 755 910	57	90	$0.048	*a* $0.034	$0.034	......	.116
1880	England and Wales..........	......	......	......	202 050 891	......	......	*b*	*b*	*b*	8.30	.1660
"	Massachusetts	2 626	16	56	24 075 392	63	98	$0.054	*a* $0.033	$0.042	......	.139
1881	England and Wales..........	......	......	......	208 517 549	......	......	*b*	*b*	*b*	8.34	.1668
"	Massachusetts	2 755	16	60	27 205 783	64	104	$0.061	*a* $0.034	$0.043	......	.138
1882	England and Wales..........	......	......	......	217 393 015	......	......	*b*	*b*	*b*	8.37	.1674
"	Massachusetts...............	2 778	16	59	29 052 800	66	107	$0.060	*a* $0.033	$0.046	......	.139
1883	England and Wales..........	13 215	......	......	226 351 389	......	......	*b*	*b*	*b*	8.41	.1682
"	Massachusetts...............	2 783	15	60	31 150 823	66	107	$0.062	$0.034	$0.050	......	.146
1884	England and Wales..........	13 340	......	......	228 972 559	......	......	*b*	*b*	*b*	8.49	.1698
"	Massachusetts...............	2 852	15	60	32 304 333	67	100	$0.056	$0.033	$0.045	......	.134
AVERAGE.	England and Wales..........	......	......	......	......	......	......	*b*	*b*	*b*	8.39	.1678
"	Massachusetts	......	......	......	......	......	......	$0.057	$0.034	$0.043	......	.134

NOTES.—*a* The author has no official data for these years. The amount given is the average cost for the years 1883 and 1884.

b The Board of Trade includes all these items under the general head of "Locomotive Power," which is included in the total average at the bottom of this column.

In the above table all wages on the American Railroads have been reduced on the basis previously stated, to equalize them with the English and Welsh prices.

All data in the above table relating to the English and Welsh Railroads have been taken from the Reports of the Board of Trade of the United Kingdom; and all relating to the American Railroads have been taken from the reports of the Railroad Commissioners of Massachusetts, embracing in all thirty-two distinct railroads.

Statement showing th
Date of commenci
age Miles per Day.

NUMBER OF ENGINES.	NAM
66	Experiment...
300	Compound ...
301	Economist ....
302	Velocipede....
303	Hydra ....
305	Trentham....
306	Knowsley.....
307	Victor ....
310	Sarmatian....
311	R. F. Roberts
315	Alaska.... ...
321	Servia ....
323	Britannic .....
333	Germanic ....
353	Oregon ....
363	Aurania......
365	America......
366	City of Chica
372	Empress.....
374	Emperor .....
503	Dreadnought .
504	Thunderer ...
508	Titan.........
519	Shooting Star
520	Express ......
1102	Cyclops ......
1104	Sunbeam.....
1111	Messenger....
1113	Hecate ....
1115	Snake.........
1116	Friar ....
1117	Penguin .....
1120	Apollo ....
2063	....
	Grand Total

the 5:5 P. M. passenger train from Liverpool to Euston between Liverpool and Crewe, the load consisting of eighteen vehicles weighing 227 tons 15 hundred-weight, or, including the engine and tender, a total load of 292 tons 15 hundred-weight. The journey from Edge Hill to Crewe, a distance of 34¼ miles, was run in forty-five minutes, giving a speed of 43.4 miles per hour, the engine steaming freely throughout the trip."

On June 30th, 1885, the preceding mileage had been increased to 2 226 112 miles, with an average consumption of coal per mile run of 29.01 pounds, of which 1.02 pounds was consumed in starting the fires, leaving 27.99 pounds average consumption of coal per engine mile.

The preceding is a remarkably good showing, both for high average daily mileage during actual running days, and for small consumption of coal.

Mr. T. N. Ely, M. Am. Soc. C. E., General Superintendent of Motive Power of the Pennsylvania Railroad, sends the author the average locomotive mileages given in Table No. 34.

TABLE No. 34.

Statement showing Total Mileage of 48 Standard Passenger Locomotives during the Years 1882, 1883 and 1884, on Pennsylvania Railroad Division.

Mileage.	Mileage.	Mileage.	Mileage.
230 637	151 606	132 234	112 823
220 134	150 057	129 806	109 796
220 120	148 831	128 746	109 516
203 916	148 008	127 387	109 344
184 805	147 009	123 917	108 879
173 850	146 317	120 567	107 820
171 979	145 852	119 155	106 843
170 321	141 126	116 747	106 749
163 052	140 746	115 479	105 903
156 241	136 905	115 443	105 588
152 446	136 850	114 208	105 188
152 014	135 989	113 614	104 661

Total mileage of 48 locomotives, 3 years........... 6 679 224
Average " " " 139 151
" " " per year.......... 46 384

Daily average (313 days = 1 year) 131 miles.

The separate mileages of these locomotive are very astonishing, averaging in three years for six days in the week as follows:

First on the above list	251	miles daily.
Second on the above list	240	"
Third on the above list	240	"
First ten on the above list	202	"

Under a recent date, Mr. Ely writes as follows to the author:

"As a matter of information bearing upon the durability of construction of American locomotives, locomotive No. 1017, class 'O,' 18 × 24, with 63" drivers, using bituminous coal, running with passenger trains on the Pittsburgh Division, ran a total of 41 510 miles in three consecutive months last. There are many other locomotives on this road that have made very large mileages, but this is the greatest for so short a period of time."

This average for ninety days of 461 miles daily, speaks well for the American engine, and also for workmanship at the Pennsylvania Railroad shop at Altoona.

The following statement has been furnished to the author by Mr. W. W. Evans, M. Am. Soc. C. E.

(Statistics given to W. W. Evans by Wm. Buchanan, Chief Engineer of Motive Power.)

Statement of Five Years' Service of Locomotives No. 10, No. 33 and No. 34, on the Hudson River Division, New York Central and Hudson River Railroad. These engines were new when they commenced running, and have been used only on through passenger trains.

Cylinders, 17" × 24"; driving wheels, 69"; fire-boxes of steel, flues of semi-steel; weight in running order, 70 500 pounds; weight on driving wheels, 44 850 pounds; average speed, 38 miles per hour; date, from September 30th, 1877, to September 30th, 1882.

Average trains consist of

2 Baggage and mail cars, loaded		52	gross tons
2 Drawing-room or sleeping cars, loaded		64	"
5 First-class passenger cars, loaded		125	"
1 Engine	31 Tons		
1 Tender, half-loaded	22 "		
		53	"
Total train		294	gross tons

TABLE No. 35.

	Locomotive No. 10.	Locomotive No. 33.	Locomotive No. 34.	Average of all three.
Total mileage in five years	415 790	440 654	392 043	416 162
Number of days in service	1 495	1 565	1 430	1 496
Number of days idle	306	242	397	315
Actual months in service	59	58	57	58
Average miles run per month	7 047.50	7 597.50	6 878	7 174.21
Average miles run each service day	278.12	281.57	274.15	277
Average miles run per year	83 158	88 131	78 409	83 233
Gallons of oil used	2 882	3 337	3 027	3 082
Average miles run per gallon	144.27	132.05	129.51	135.27
Total cost for oil	$1 182	$1 368	$1 241	$1 264
" " waste	240	232	230	234
" " labor on engine	4 066.64	4 480.24	4 343.90	4 296.93
" " " tender	285.94	447.86	380.07	371.29
" " materials E. & T.	3 218.58	4 167.39	3 621.24	3 669.07
Average cost of labor and materials used in repairs per mile run, in cents	$1\frac{82}{100}$	$2\frac{05}{100}$	$2\frac{13}{100}$	2

The following data has been kindly furnished by Mr. Walter Katte, M. Am. Soc. C. E., Chief Engineer of the New York, West Shore and Buffalo Railway.

"In relation to the comparative speed of both ordinary and extraordinary (or special) trains now attained and in ordinary use on first-class American railways, I beg to offer the following memoranda of what is now being done on the New York, West Shore and Buffalo Railway, which exhibits the details of an extraordinary fast run made on July 9th, 1885, by a special train between Buffalo and Weehawken, a distance of 422.6 miles.

"This train consisted of a locomotive, one baggage car and two official cars, weighing in total between 155 and 156 tons, as follows:

Make-up and weight of train, exclusive of engine—

Tender with two-third load of coal and water	62 800	pounds
Baggage car, West Shore, No. 737	46 030	"
Official car, West Shore, No. 90	61 200	"
Official car, Baltimore and Ohio, No. 711	46 430	"
Total	216 460	"

Add for total weight of train—

On Buffalo Division, West End, Engine No. 45, Class B (bituminous), 94 500 pounds. Total.. 310 960 pounds

Equal to about .... 155 tons

On Buffalo Division, East End, Engine No. 50, Class B, 94 500 pounds. Total..............	310 960 pounds
Equal to about..............................	155 tons
On Hudson River Division, West End, Engine No 27, Class A (anthracite), 96 000 pounds. Total..	312 460 pounds
Equal to about..............................	156 tons
On Hudson River Division, East End, Engine No. 36, Class B, 94 500 pounds. Total.......	310 960 pounds
Equal to about..............................	155 tons

"The train (see Table 36) started from East Buffalo at 10:04 A.M., and reached Weehawken at 7:27 P.M., or 9 hours 23 minutes on the trip, making 19 stops consuming 2 hours, reducing the actual running time to 7 hours 23 minutes, or a general average of about 56 miles per hour running time. This train attained a speed of 87 miles per hour between Churchville and Genesee Junction, on the west end of the Buffalo Division; and at several other places attained speeds from 70 to 80 miles per hour.

"It is interesting to state the fact that this train was run without any preconcerted effort or preparation for it. It was run by four different engines, which were called on to take this 'special' just as they stood in their respective yards waiting to take their 'regular' trains. Nor were the enginemen informed beforehand that they were expected to make more than ordinary speed; they were simply told to see how fast they could run after getting started. The train was run subject to all the exigencies and privileges of the regular trains on the line, none of which were obstructed or interfered with. The several engines, when through with their runs, did not show the slightest signs of having made any extra effort, and were in perfect condition to turn right round and make their runs back again, if it had been desired; neither was the steam pressure greater, nor the amount of fuel consumed greater than allowable or out of proportion to the speed attained.

"Table No. 37 gives the time of nineteen regular passenger trains, running on the present summer schedule, between Weehawken and Buffalo, Syracuse, Schenectady, Albany and Kingston, which shows their average speeds to be from 28 to 37 miles per hour, including stops, and from 33 to 50 miles per hour excluding stops—on regular schedule time. When making up 'lost time,' it is not uncommon for these trains to be run at speeds fully up to 60 miles per hour between stations.

TABLE No. 36.

Summarized Record of Fast Run on the New York, West Shore and Buffalo Railway on July 9, 1885, from East Buffalo to Weehawken, 422.6 Miles. Principal Stations only.

Running Record.				Speed Record.†												
Distance Miles.	Stations.	Time.	Remarks.*	East Buffalo.	Genesee Junction.	Newark.	Syracuse.	Utica.	Frankfort.	Canajoharie.	Rotterdam Junction.	Coeymans.	Kingston.	Cornwall.	Haverstraw.	Weehawken.
0.0	Buffalo															
3.4	East Buffalo	10:04	Took train fron Niagara Falls Branch		68	67	64	62	62	60	60	60	58	58	57	57
64.3	Genesee Junction	11:00 11:07	B., N. Y. & P. grade crossing. Took water and oiled.			65	61	59	60	58	58	59	56	56	55	56
96.8	Newark	11:41 11:50	Changed engines				59	57	59	57	57	58	55	55	54	55
147.7	Syracuse	12:48 12:55	Stopped for lunch and took water					56	58	56	57	57	55	54	54	55
194.2	Utica	1:54							73	55	57	58	54	54	53	54
205.1	Frankfort	2:04 2:10	Changed engines							51	55	57	53	53	52	54
235.7	Canajoharie	2:48 2:56	Stopped for water								60	60	54	54	53	54
266.5	Rotterdam Junction	3:29 3:29	Stopped by block									61	52	51	51	53
297.8	Coeymans	4:07 4:13	Changed engines										46	50	49	52
337.8	Kingston	5:01 5:01	Grade crossing											54	51	55
373.7	Cornwall	6:20													46	55
392.8	Haverstraw	6:50 6:51	Stopped by block													62
426.0	Weehawken	7:27														

* In addition to the stops noted in this column, the following were made: Red Creek, 11:11 to 11:11, grade crossing; Lyons, held 2 minutes by freight; Clark's Mills, 1:41 to 1:41, grade crossing; So. Schenectady, 3:39 to 3:40, grade crossing; Voorheesville, 3:52 to 3:52, grade crossing; Glenerie, stopped 3 minutes for water; Marlborough, 5:30 to 5:39, stopped by block; Newburgh, 5:59 to 6:00, stopped by block; New Durham, 7:23 to 7:23, stopped by block.

† Speed is given in nearest even miles per hour deducting actual stops, plus two minutes per stop for losing and gaining headway.

TABLE No. 37.

Speed Table New York, West Shore and Buffalo Railway.—Time Table No. 11, July 2d, 1885.

Train No.	Miles Run.	Between Weehawken and	Time. Leave.	Time. Arrive.	Time. Consumed. H. M.	Stops. Station.	Stops. Junction.	Stops. Time Lost. H. M.	Actual Time Running. H. M.	Average Miles Per Hour. Including Stops.	Average Miles Per Hour. Excluding Stops.
59	422.6	Buffalo	7:40	9:50	14 10	93	6	5 40	8 30	29.83	49.71
63	152.6	South Schenectady	9:20	1:30	4 10	4	1	25	3 45	36.62	40.69
51	422.6	Buffalo	10:30	11:55	13 25	16	7	2 03	11 22	31.45	37.17
69	88.2	Kingston	11:35	2:10	2 35	5	0	16	2 19	34.14	38.07
53	278.3	Syracuse	[illegible]	8.55	9 10	46	5	2 57	6 13	30 36	44.76
67	152.6	South Schenectady	4:05	8:10	4 05	4	1	25	3 40	37 37	41.61
65	141.3	Albany	4:15	9:05	4 50	26	1	1 32	3 18	29.23	42.81
57	422.6	Buffalo	6:30	6:00	11 30	8	7	1 19	10 11	36.74	41.49
55	422.6	"	8:30	11:40	15 10	19	7	2 18	12 52	27.86	32.84
62	422.6	"	3:40	6:30	14 50	46	6	3 22	11 28	28 48	36.83
54	422.6	"	4:50	7:00	14 10	11	7	1 23	12 47	29 83	33.05
66	141.3	Albany	4:10	9:05	4 55	27	1	1 35	3 20	28 73	42.39
52	422.6	Buffalo	9:20	10:20	13 00	16	7	1 53	11 17	32 50	37.45
56	278.3	Syracuse	5:00	2:40	9 40	50	8	3 08	6 32	28 78	42.59
64	152.6	South Schenectady	1:35	6:00	4 25	6	1	32	3 53	34.55	39.29
60	422.6	Buffalo	5:10	7:00	13 50	63	6	4 27	9 23	30 51	45.03
70	88.2	Kingston	5:35	8:00	2 25	4	0	13	2 12	36.49	40.09
68	152.6	South Schenectady	5:13	9:20	4 7	5	1	28	3 39	37.06	41.80
58	422.6	Buffalo	9:30	9:50	12 20	14	6	1 53	10 27	34 26	40.44

"The character of the engines doing this service, with data of their dimensions, weights, etc., is as follows:

General dimensions, weights, etc., of locomotives. Class A (anthracite) and B (bituminous):

Cylinders—	
Diameter and stroke	18 x 24 inches
Ports—length	16 "
Steam port—width	1¼ "
Exhaust port—width	3¼ "
Valves: Allen Richardson—	
Travel (maximum)	5½ "
Outside lap	1 "
Inside lap	$\frac{1}{16}$ "
Lead in full gear	$\frac{1}{32}$ "
Exhaust nozzles: high double—	
Diameter	3⅛ "
Height from base of stack	18 "
Boiler pressure per square inch	140 pounds
Smoke-stack—Height above rail	14 ft. 5¼ inches
Diameter at top	20½ "
Diameter at base	18 "
Smallest internal diameter	15 "
Engine and tender truck wheels: Allen paper.	
Capacity of tender—	
Coal	15,000 pounds
Water	3,000 gallons
Boiler—	
Diameter of smallest ring	55 inches
Length of barrel	10 ft. 11 "
Tubes—	
Number	188
External diameter	2 inches
Length between sheets	10 ft. 10⅝ "
Area through	3.17 square feet

Heating surface—

Tubes....................................	1,084 square feet
Fire-box....................................	128 "
Total....................................	1,212 "

Firebox—

	Class A.	Class B.
Length outside..............................	10 ft., 9 inches	6 ft., 7 inches
Width outside....................	48 "	$41\frac{3}{4}$ "
Depth inside front...............	$49\frac{3}{4}$ "	$74\frac{3}{4}$ "
Size of grate....................	$120\frac{3}{8}$ x $40\frac{1}{4}$ "	$70\frac{3}{8}$ x $34\frac{1}{2}$ "
Grate area......................	34 square feet	17 square feet
Weight of engine in working order.....	96,000 pounds	94,500 pounds
" " on truck............	32,000 "	32,000 "
" " on drivers...........	64,000 "	62,500 "
" tender loaded..............	76,000 "	76,000 "
" " empty...............	36,400 "	36,400 "
Maximum weight, engine and tender..	172,000 "	170,500 "
Average " " " " ..	154,000 "	154,000 "

"Their trains vary from four to twelve cars, and often have on one train three baggage and express cars, and three or four Pullman parlor and sleeping cars.

TABLE No. 38.

PHYSICAL CHARACTERISTICS OF WEST SHORE ROAD.

ELEMENTS.	BUFFALO DIVISION.		HUDSON RIVER DIVISION.		ENTIRE LINE.
	West End.	East End.	West End.	East End.	
PROFILE.					
Level.................... } Percentages.	16.93	27.03	29.94	42.18	30.18
Up grade (going East) } Percentages.	45.59	37.50	29.59	30.41	35.62
Down " " " } Percentages.	37.48	35.47	40.47	27.41	34.20
Up grade (going East) } Average feet per mile..	16.25	15.88	16.36	16.96	16.32
Down " " " } Average feet per mile..	18.75	18.49	17.66	22.77	19.51
ALIGNMENT.					
Tangents.. } Percentages..............	82.52	83.44	73.85	84.26	82.06
Curves.... } Percentages..............	17.48	16.56	26.15	15.74	17.94
Curvature, average, degrees	1° 20′ 57″	1° 46′ 11″	2° 04′ 40″	1° 48′ 17″	1° 46′ 34″

"It will be seen by inspecting the above table of the physical characteristics of the road, that it is unusually (for the Eastern States) favorable for making fast time with small effort, its grades over the entire line averaging only 16⅓ feet per mile rising east, and 19.5 feet per mile going west, while the percentage of grade to level line is 70 per cent. of gradients to 30 per cent. of level—the upward and downward gradients being about equal, or 35 per cent. each; so that a train running in either direction always has the advantage of 30 per cent. of level and 35 per cent. of down grades in its favor.

"The percentage of straight line to curves is also remarkably high, being 82 per cent. straight to 18 per cent. curve. The average degree of curvature over the entire line is about 1¾ degrees, the standard maximum permanent curvature being 4 degrees.

"The road bed and bridges are of thoroughly first-class character; the track is double and laid on the break-joint-system, with 67 pound steel rails on cross-ties averaging 2 800 to the mile; the joints are made with rolled-iron double 'angle splice' bars, weighing 44 pounds per pair, and are 36 inches in length, with three cross-ties under the joints covering the whole length of the splice bars; the track is well ballasted throughout, generally with good gravel, with a considerable proportion of machine-crushed stone ballast."

ENDURANCE OF LOCOMOTIVES.

In order to compare the endurance of the locomotives of the two countries, Table No. 39 was constructed. For the English railroads the data were taken from the Board of Trade Reports; for the American, from the Reports of the Railroad Commissioners of Massachusetts, Reports of the Companies and Poor's Manual.

For the English railroads the average mileage is very uniform, being from 60 to 70 miles daily for 313 days in the year.

The American railroads do not show such uniform results, the mileage being on the smaller Massachusetts railroads about 60 miles; on the Pennsylvania and New York Central, 80 miles; and on the New York, New Haven and Hartford, 96 miles. The last is a remarkable record of locomotive endurance or durability, especially as it was the same for the two previous years.

TABLE No. 39.

Showing the Average Annual Revenue Mileage made by all the Locomotives in 1884 on all the Principal Railroads of the United Kingdom and some of the Principal Railroads of the United States.

Name of Railroad.	Total Number of Locomotives.	Mileage.	
		Total.	Average.
United Kingdom.			
Great Eastern	655	14 063 700	21 458
Great Northern	789	16 978 030	21 498
Great Western	1 577	30 457 267	19 314
London and North Western	2 476	38 184 328	15 422
London and South Western	501	11 183 874	22 323
London, Brighton and South Coast	410	8 136 077	19 844
London, Chatham and Dover	180	3 889 988	21 611
Midland	1 697	33 261 729	19 600
North Eastern	1 470	23 873 903	16 241
Caledonian	690	12 489 848	18 101
North British	586	11 676 275	19 958
Great Northern of Ireland	127	2 636 570	20 760
Great Southern and Western of Ireland	163	2 913 669	17 874
Totals and Average	11 320	209 735 248	18 528
United States.			
Pennsylvania:			
Pennsylvania Railroad Division	815	20 791 778	25 511
United Railroads of New Jersey Division	335	8 408 926	25 101
Philadelphia and Erie Division	110	2 353 131	21 392
Baltimore and Ohio	603	11 405 777	18 915
New York Central and Hudson River	657	16 452 835	25 043
New York, Lake Erie and Western	805	17 092 582	21,233
Boston and Albany	243	4 960 185	20 407
Fitchburg	100	1 986 319	19 863
Boston and Lowell	147	1 915 812	13 028
Boston and Maine	92	1 829 573	19 887
Eastern	115	2 142 225	18 628
Boston and Providence	57	973 646	17 081
New York and New England	147	2 350 058	15 986
Old Colony	125	2 428 954	19 432
New York, New Haven and Hartford	128	3 827 685	29 904
Totals and Average	4 479	98 918 986	22 085

Locomotive Earnings.

In order to ascertain the money-earning qualities of the locomotives of each country, Table No. 40 was constructed, in which fourteen railroads, embracing all the principal roads of the United Kingdom, are compared with an equal number of American roads.

TABLE No. 40.

Showing the Average Annual Earnings of Locomotives on Different Railroads in 1883.

Name of Railroad.	Total Number Locomotives.	Earnings from Traffic. Total.	Average per Locomotive.
United Kingdom.			
Great Eastern	615	£3 279 354	£5 330
Great Northern	733	3 522 035	4 805
Great Western	1 577	7 817 742	4 957
London and North Western	2 451	10 362 520	4 228
London and South Western	471	2 797 550	5 940
London, Brighton and South Coast	410	2 114 879	5 158
London, Chatham and Dover	168	1 095 317	6 520
Midland	1 629	7 363 217	4 520
North Eastern	1 462	6 699 891	4 583
South Eastern	325	1 949 391	6 000
Caledonian	690	2 923 890	4 237
North British	573	2 611 803	4 558
Glasgow and South Western	290	1 111 796	3 834
Great Southern and Western of Ireland	160	753 396	4 709
Totals and Average	11 554	£54 402 781	£4 709
United States.			
Pennsylvania—Pennsylvania Division	795	$32 017 813	$40 273
Do. United Railroads of New Jersey	330	14 408 540	43 662
Do. Philadelphia and Erie	110	4 108 843	37 353
New York, Lake Erie and Western	785	22 040 595	28 077
New York Central and Hudson River	655	29 359 745	44 824
Boston and Albany	244	8 103 957	33 213
Fitchburg	98	2 825 024	28 827
Boston and Lowell	77	2 102 887	27 310
Boston and Maine	89	2 915 944	32 763
Eastern	109	3 417 267	31 351
Boston and Providence	53	1 646 962	31 075
New York and New England	151	3 376 311	22 360
Old Colony	120	4 158 977	34 658
New York, New Haven and Hartford	122	6 650 549	54 513
Totals and Average	3 738	$137 133 414	$36 686

Notwithstanding that the average charges, both for passengers and freight, are much lower in the United States than in the United Kingdom, the average earnings of the locomotives on the above fourteen American railroads are 55 per cent. greater than the average of the fourteen roads of the latter country as named above. This speaks well for the money-making quality of the American locomotive, as well as for its durability.

The London and North Western Railway has about the same amount of traffic-earnings as the three divisions of the Pennsylvania Railroad

named (the other divisions have been excluded, as being in the level Western States), yet the latter company only has about half the number of locomotives, notwithstanding this road has very heavy grades, and with one summit 2 154 feet above the sea.

Relation between Train Load and Charges.

Table No. 41, compiled from the Reports of the New York Central and Hudson River Railroad, shows the cost of transporting a ton of freight for 14 years—from 1870 to 1883, inclusive—and also the average load of freight trains for each year. It will be noticed that the average earnings or charges per ton per mile have decreased one-half, and the average loads of freight trains have doubled within the 14 years.

TABLE No. 41.

Freight Earnings, Expenses and Profit per Ton-mile, and per Train-mile, and average Train-load.

Year Ending September 30th.	Earnings per ton-mile on freight.	Expenses per ton-mile on freight.	Profit per ton-mile on freight.	Earnings per train-mile on freight.	Expenses per train-mile on freight.	Profit per train-mile on freight.	Average number of tons of freight in train-load.
	Cents.	Cents.	Cents.				
1870.............	1.88	1.15	0.73	$1.95	$1.19	$0.76	103
1871.............	1.62	1.01	0.61	2.07	1.28	0.79	127
1872.............	1.59	1.12	0.47	2.05	1.45	0.60	129
1873.............	1.57	1.02	0.55	2.02	1.32	0.70	129
1874.............	1.46	0.98	0.48	2.03	1.37	0.66	139
1875.............	1.27	0.90	0.37	2.11	1.49	0.62	166
1876.............	1.05	0.71	0.34	1.89	1.28	0.61	180
1877.............	1.01	0.69	0.32	1.68	1.15	0.53	166
1878.............	0.93	0.59	0.34	1.71	1.10	0.61	183
1879.............	0.78	0.54	0.24	1.52	1.05	0.47	191
1880.............	0.87	0.54	0.33	1.92	1.18	0.74	218
1881.............	0.78	0.56	0.22	1.70	1.23	0.47	217
1882.............	0.73	0.60	0.13	1.62	1.31	0.31	219
1883.............	0.91	0.68	0.23	1.82	1.37	0.45	199

A similarly constructed table for the Pennsylvania Railroad shows that, within the last 20 years, the average freight charges have been reduced two-thirds, while the average load of freight trains has been more than doubled.

The workings of other American railroads also show the great economy in running heavy freight trains.

The English roads, on account of their good alignment and easy

grades, ought to be able to run heavier freight trains than the American, with proportionate saving in cost; this would enable them to reduce their charges, or pay larger dividends.

Other causes have contributed to this reduction in the cost of transportation, besides the increased load of freight trains; this, however, must have great influence on the result, as now one engine and one set of men do more work than two engines and two sets of men did formerly.

The author has been desirous to compare impartially and closely the operating expenses of the railroads of the United Kingdom and those of the United States—the result of comparing the cost of motive power on the two systems has been as great a surprise to him as it will be to any one.

At the very outset he was met with the apparently insurmountable obstacle that the English do not keep any accounts showing the passenger or ton mileage, which is so necessary for comparing operating expenses. After diligent investigation and research, he made his rules for estimating and supplying this deficiency (see page 16). Of course these are only his views and analysis of the data available to him, which he is willing to change promptly by any reliable or official data. He hopes that the railroads which are so largely interested in this question, will promptly replace his estimates by their official figures. Until this is done, he claims that these figures should be accepted as correct.

In conclusion, the author begs the indulgence of his readers for the imperfection of this paper. The data was collected, compiled and analyzed while he was very closely occupied in other professional duties. He is aware that the arrangement of many of the tables could be much improved and others advantageously made, but he cannot do this, for the want of the necessary time. Doubtless, many clerical errors will be discovered, as for want of time many calculations have not been checked.

All who are interested in this line of study can, from the data here given, make their own tables and draw their own conclusions, as the author has done.

CONCLUSIONS.

In the opinion of the author, neither the English or American railroad is perfect in itself, if the object of a railroad is to give the greatest amount of comfort to the passengers for the least amount of money, and the cheapest freight charge to the shipper. In this light the Pennsylvania Railroad comes nearer perfection than any other, but it has the serious fault of many level road-crossings. All other large American railroads have, in addition to this defect, that of the absence of the block system. With these two faults alone, they are far from being perfect, to say nothing of minor improvements required, such as good station buildings, etc.

Although the English cars are far from being as comfortable for travelers as the American, yet the English engineer can do but little now to remedy it, owing to the low and narrow cars he is obliged to run. Perhaps the most that could be done would be economising in the cost of motive power, the general introduction and use of the American baggage check on all connecting linos, thereby increasing the comfort of passengers, and also saving a large expense to the railroads in saving the cost of many unnecessary porters; warming the cars in winter; general use of the bogie truck under passenger cars, thereby diminishing the constant jarring motion now so great in them.

The English road-bed, superstructure and block signaling system is all that could be desired.

From superficial observation, it is difficult to say what is the cause of the great additional cost in motive power in operating the English railroads, when it should be much less than that of the American railroads, as, owing to their average superior construction, with easier grades and curves, it should not be much over half, instead of being nearly double.

Apparently the most prominent cause of this increased cost is the great speed and small tonnage of the freight trains, and too many passenger trains lightly loaded.

Perhaps the American bogie-truck rolling stock runs with less friction than the rigid wheel-base rolling stock used on the English roads.

The English railroads have cost per mile more than three times as much as the American, yet they only save eight per cent. of the annual operating expenses. In other words, to save one-twelfth of the annual

operating expenses the cost of construction has been increased more than three times. The preceding comparison would be still more striking if we brought into calculation the comparative cost in the two countries of the different items included under the heading of "Maintenance of way," "Locomotive Charges" and "Repairs of Carriages." Probably 90 per cent. of these are made up of labor, fuel, iron, steel, etc., all of which would average, in 1883, fully one-fourth higher in the United States than in the United Kingdom. This speaks very well for the American system, that, notwithstanding it costs much less to construct, after paying higher prices for labor and materials—and for financial reasons the location is often faulty, and the superstructure of perishable materials—yet it is operated for less than the English roads are, when due allowance is made for the difference in the price of labor and materials that enter into operating expenses. Notwithstanding these disadvantages, for similar accommodation, the passenger rates and freight charges are much less on American than on English railroads.

One of the principal items of the greater cost of English railroad construction over the American, is the necessity of having much straighter alignment or easier curves, so that it can be safely operated by the rigid and long wheel-base rolling stock in use there.

The Baltimore and Ohio Railroad is a sample of what can be done with the American rolling stock. This road is built through a very difficult and rugged country, which compelled a very poor alignment, with nearly one-half of the entire length in curvature, which curves run up to 600 feet radii, and long grades running up to 120 feet per mile. The country affords no natural advantages whatever. Yet, with all these drawbacks, this road does a very large and profitable business, paying annually ten per cent. dividend, and running passenger trains safely at very high speed.

All this is done on a road that could not be operated with rolling stock built on the English system. The extra cost of enlarging these curves to adapt them to English rolling stock would be so great as to be commercially impracticable. It is not difficult to appreciate the great difference in cost of construction, in an extremely rough country, of a railroad with curves 600 feet, or 2 640 feet radii.

Unquestionably the American system of construction is the best for new countries, or where cheapness of construction is desirable. The American rolling stock, with the bogie truck, will run safely and rapidly

over roads of inferior construction, or sharp curves that would be impossible for rolling stock constructed on the English type of long and rigid wheel base. The American type is especially adapted for military purposes. During the late American war some military railroads were operated successfully, with the ordinary American rolling stock, with curves of 50 feet radius. The New York Elevated Railroad has been operated for years (it transported last year 97 000 000 passengers) without accident, and has many curves under 100 feet radius. Through an ordinary rough country, a railroad to be operated with the American type of rolling stock could be constructed in one-fourth of the time and for one-fourth of the money that one suitable for the English rolling stock could be built.

It would certainly pay the management of the English railroad companies to investigate the cause of the extra cost of motive power on their roads, and, if possible, remedy it. If this can be done, they will be able to *decrease their operating expenses* over 8 per cent., without making any changes whatever in the present prices. This will enable most companies to *increase their dividends* largely—probably over 4 per cent.

For what *is* done in the United States *ought* to be done in the United Kingdom.

SUPPLEMENTARY PAPERS.

SUPPLEMENTARY PAPERS.

Supplementary Paper Read May 5, 1886.

Since the first part of my paper was prepared, I have passed nearly a year in England, observing closely the railroad question, especially the data from which I obtained the passenger and ton mileage—which is really the basis of the whole comparison. I again repeat my concluding remarks from page 75 of my paper: "He (the author) hopes that the railroads which are so largely interested in this question, will promptly replace his estimates by their official figures. Until this is done, he claims that these figures should be accepted as correct."

The following Table, No. 42, which I had not time to finish before my paper was read, shows the expense of transporting one ton or one passenger one mile on some of the leading railroads of England and the United States, and also the comparative expense per train mile. To make the comparison more general, all the railroads of England and Wales, embracing 13 340 miles, are compared with all the roads of Massachusetts, embracing sixty-three companies, operating 2 852 miles, averaging less than fifty miles of road to each company. It is evident that these small companies are operated at much greater expense, in proportion to their business, than the larger ones, as they cannot afford to hire such efficient management, or buy their supplies on such favorable terms as the larger companies, who make their purchases in very large quantities.

TABLE No. 42.

Showing the Cost per Train Mile and Ton, or Passenger Mile in Operating different Railroads in England and the United States.

NAME OF RAILROAD.	Total Length of Line Operated.	Total Mileage.		Total Passenger and Ton Mileage.	Average Load of Train.		Average Length of Haul.		Average Cost of Operating Expenses.	
		Passenger.	Ton.		Passenger.	Ton.	Passenger.	Ton.	Per Train Mile.	Transporting one Passenger, or one Ton, one Mile.
United Kingdom, 1883.	Miles.						Miles.	Miles.	Dollars.	Cents.
Great Northern	768	286 512 050	502 973 520	789 485 570	35	61	10	53	0.587	1.22
North Eastern	1 534	359 184 052	1 159 691 280	1 518 875 332	37	78	9	29	0.677	1.10
Midland	1 381	432 151 874	1 222 309 920	1 654 461 794	33	61	12	46	0.563	1.12
London and North Western	1 793	745 749 134	1 511 779 440	2 257 528 574	39	78	12	43	0.655	1.11
Great Western	2 268	642 025 920	1 042 489 200	1 684 515 120	45	65	12	43	0.600	1.09
Great Eastern	1 049	386 454 286	369 094 320	755 548 606	45	69	5	52	0.630	1.15
London and South Western	721	406 375 606	216 649 920	623 025 526	51	71	9	59	0.716	1.28
London, Chatham and Dover	160	195 917 102	60 534 960	256 452 062	62	59	5	28	0.526	1.14
Caledonian	877	195 721 238	456 161 700	651 882 938	37	69	10	30	0.636	1.16
North British	1 006	193 726 340	396 243 120	589 969 460	38	61	8	29	0.570	1.12
London, Brighton and South Coast	403	369 993 492	130 318 080	500 311 572	57	91	6	51	0.661	1.06
1884.—All the Railroads of England and Wales (average cost per mile, £49 258)	13 340	5 199 240 104	....	12 872 762 744	43	72	8	35	0.640	1.14
United States, 1884.										
Boston and Lowell	550	61 343 056	59 427 991	120 771 047	43	97	14	40	1.083	1.72
Boston and Maine	204	89 587 566	44 937 544	134 525 110	69	83	13	47	1.137	1.55
Boston and Providence	68	55 200 708	21 814 483	77 015 191	76	89	10	80	1.399	1.77
Old Colony	468	116 745 901	57 899 872	174 645 773	71	72	15	86	1.212	1.68
New York, New Haven and Hartford	265	206 677 775	125 743 803	332 421 578	87	86	26	58	1.261	1.45
New York, Lake Erie and Western	1 029	169 599 245	1 794 946 519	1 964 545 764	45	289	19	162	0.745	0.62
N. Y. Cent. and Hudson River Railroad	993	387 329 886	1 970 087 115	2 357 919 001	60	196	69	198	1.065	0.74
Penn. Railroad, Penn. Railroad Div.	1 471	244 710 876	2 996 892 567	3 241 603 443	42	205	21	184	0.845	0.53
All the Railroads of Massachusetts (average cost per mile, $69 281).	2 852	1 007 136 376	1 229 368 472	2 236 504 848	67	110	15	60	1.173	1.38

Explanation of Tables.

In all cases the aggregate daily train mileage was obtained by assuming that the reported annual revenue train mileage was made in 315 working days; thus divide total annual revenue freight and passenger train miles by 315; then divide this quotient by the length of line operated.

In all cases the revenue mileage only has been counted, the working trains and switching mileage being excluded.

Except in the case of the New York Central and Hudson River Railroad, all canal, dock and steamboat expenditures have been excluded.

Mr. T. Russell Crampton, M. Inst. C. E., the celebrated English engine-builder, in a recent paper before the French Society of Engineers (see *London Engineer* of this year, page 354), estimated the average cost on six of the largest English railroads of repairs and renewals of locomotives at over 3d. per train mile; this is somewhat higher than my figures from the official reports of the companies.

No reports or returns have been received for 1885 from the English railroads or the Board of Trade.

The cost has been taken from the reports of the respective companies, or from the Reports of the Board of Trade of the United Kingdom.

Except when otherwise stated, taxes and duties have been included in the operating expenses.

I will repeat again, that no returns are made in England of the ton or passenger mileage, nor is there any attempt made to separate the cost of the freight or passenger traffic; consequently it has been necessary for comparison to add them together.

My plan for estimating the ton and passenger mileage is fully described on page 16.

TABLE No. 43.

Showing the Average Cost of Transporting One Ton or One Passenger One Mile on the Boston and Albany Railroad for the Last 18 Years.

Year.	Cents.	Year.	Cents.
1868	.0202	1877	.0088
1869	.0188	1878	.0083
1870	.0174	1879	.0071
1871	.0178	1880	.0087
1872	.0171	1881	.0083
1873	.0172	1882	.0083
1874	.0122	1883	.0090
1875	.0111	1884	.0081
1876	.0096	1885	.0072

By inspecting Table No. 42, it appears that the cost of transporting one ton one mile in England and Wales is about the same as transporting one passenger the same distance; this is shown in the last column under the head, "Cost of transporting one passenger, or one ton, one mile." This cost is very uniform on all the English railroads, notwithstanding the great variation in the proportion of total ton and passenger mileage, running from one passenger to three tons on the Midland and North Eastern Railways, costing 1.12 and 1.10 cents respectively, to three passengers to one ton on the London, Brighton and South Coast, and London, Chatham and Dover Railways, which cost 1.05 and 1.14 cents respectively.

This result is the natural consequence of the small average load on the freight trains, which resemble too closely for economy the passenger trains in speed, load and cost.

The average cost in 1884 of the train mile on all the railroads of England and Wales was $0.64. On all the railroads of Massachusetts it was $1.17, or nearly double, while the average train load is more than fifty per cent. larger in passengers and tons on the Massachusetts railroads.

The average cost in 1884 of transporting one passenger, or one ton, one mile on the English and Welsh railroads, was $0.0114; on the railroads of Massachusetts it was $0.0138, or 21 per cent. more. This is the actual

cost: no allowance has been made for the difference in cost of labor, materials and fuel. The pay of the engine-drivers and firemen in Massachusetts is more than double what it is in England and Wales. The price of fuel is fully three times as much. All wages will probably average 50 per cent. more, and all materials, except ties (sleepers) and lumber, are higher.

It is evident that if proper reductions are made for the difference in the cost of fuel, labor and materials in the two countries, the American railroads are operated much more economically than those of the United Kingdom, otherwise it will have to be admitted that American labor, at nearly double the price, is as cheap as English at about half the price Either the American railroad management is more economical, or the American labor is more efficient.

If the American rolling stock is not better than the English, why have the Midland and other English railroads adopted so extensively the bogie-truck? And why has it been adopted so thoroughly in Canada, where all the railroads were built by English capital, and mostly by English engineers? Many roads were equipped at first with English-built rolling stock, which was afterwards changed to the American type?

It is instructive to compare the progress made in railroad traffic and its economics within the past thirty years. The able work of Messrs. Alexander L. Holley and Zerah Colburn* gives very reliable data for the years 1855 and 1856. In the following comparisons all the figures given for these years have been taken from their work, except those relating to the Pennsylvania Railroad. The figures for 1884 for English railroads have been taken from the Railway Returns of the Board of Trade, and for the American railroads from the Reports of the Railroad Commissioners of New York and Massachusetts.

*Strange as it may seem, it is only within the last few days that I have seen, for the first time, this book. At the time it was published and for many years afterward, I was engineering near the top of the Andes in South America, far removed from book-stores and libraries. Messrs. Holley and Colburn used the same plan that I did for estimating the ton mileage of the English railroads.

TABLE No. 44.

Comparison of Railroad Traffic in England and the United States in the Years 1855 or 1856 and 1884.

	1855 or 1856.	1884.
Cost per train mile:		
All railroads in England	*a* $0.68	*la* $0.61
London and North Western	*a* 0.79	*a* 0.63
All railroads in New York	*a* 1.00	*b* 1.01
All railroads in Massachusetts	*a* 1.05	*b* 1.17
Pennsylvania Railroad	*h* 1.39	*h* 0.84
Cost of transporting one ton or one passenger one mile:		
All railroads of England	*a* 0.0115	*a* 0.0115
All railroads in New York	*a* 0.0160	*a* 0.0078
Pennsylvania Railroad	*h* 0.0231	*h* 0.0054
Average train load—passengers:		
All railroads of England	46	43
All railroads of New York	73	51
Pennsylvania Railroad	*h* 57	*h* 42
Average train load—tons:		
All railroads of England	55	72
All railroads of New York	71	183
Pennsylvania Railroad	*h* 61	*h* 205
Average charge per ton per mile:		
All railroads of England	*c* $0.0275	*c* $0.0200
All railroads of New York	*f* 0.0250	0.0083
Pennsylvania Railroad	*h k* 0.0375	*h* 0.0074
Average charge per passenger per mile:		
All railroads of England	0.0252	*d* 0.0209
All railroads of New York	0.0198	*f* 0.0208
Pennsylvania Railroad	*h* 0.0325	*h* 0.0242

a—Exclusive of taxes and duties.

b—Inclusive of taxes and duties.

c—Messrs. Holley and Colburn estimate the average charge for all kinds of freight in 1855 was $0.0275 per ton of 2 000 pounds. My estimate in 1884 is $0.0200 per ton of 2 240 pounds. This, probably, is one-fourth too low.

d—Including first, second and third-class ordinary and season tickets. Without the season tickets the average is estimated at $0.0233.

f—For 1856, from the report of the State Engineer.

h—For 1856 and 1884, from reports of the Pennsylvania Railroad Company.

k—Exclusive of State tolls.

l—Including taxes and duties, $0.64.

From the preceding table it appears that from 1855 to 1884, thirty years, the railroads of England have reduced their expenses per train mile 10 per cent., and have decreased their train load in passengers 7 per cent., and increased their train load in freight 31 per cent.

The cost of transporting one passenger, or one ton, one mile has remained practically the same, being in 1855, 1.15 cents, and in 1884, 1.13 cents.

The average freight charge in 1855, per ton of 2 000 pounds, was 2.75 cents; in 1884, was 2 cents per ton of 2 240 pounds. (This is the price I estimate; probably 2.5 cents would be more correct.) The average charge or fare per passenger per mile in 1855 was 2.52 cents; in 1884 it was 2.09 cents. This last includes all three classes, and ordinary and season tickets; without including season tickets, the average fare for all classes I estimate at 2.33 cents per mile.

In 1855 the average cost per train mile on all the railroads of New York was $1; in 1884 it was $1.01, an increase of one per cent. The train load in 1855 averaged 73 passengers; in 1884 the average was 51, a decrease of 30 per cent; while the freight train load had increased from an average of 71 tons in 1855 to 183 tons in 1884, a gain of 159 per cent. The average cost of moving one ton, or one passenger, one mile in 1855 was 1.60 cents; in 1884 it was .78 cents, a decrease of 51 per cent.

The Pennsylvania Railroad in 1856 charged per mile per passenger $0.0325; in 1884, $0.0242, showing a reduction of one-fourth. In 1856 the freight charge per ton per mile (exclusive of State tolls) was $0.0375; in 1884 it was $0.0074, a reduction of 80 per cent. In the same time the cost of transporting one passenger, or one ton, one mile decreased from $0.0231 to $0.0053, or 76 per cent.

On the American railroads much greater saving has been made in the freight than in the passenger traffic.

The English railroads, in economical workings and appliances, have apparently remained stationary during the last thirty years, while the American roads have improved so as to reduce the operating expenses more than one-half. On freight alone some roads have reduced their expenses and charges 80 per cent.

SUPPLEMENTARY PAPER READ JULY 5TH, 1886.

In my previous paper the comparisons were confined to the railroads in the Middle or Eastern States. In this paper, with three exceptions, I will include in the comparisons the railroads in the Western and Southern States. These roads may be said to represent the true type of American railroad practice—they were cheaply constructed, and have been or are gradually being perfected, mostly from the earnings, while being operated. They are in the transition stage. Many bridges, buildings, etc., of wood, have been or are being replaced with iron or other durable material; iron rails with steel rails, etc. Until these changes are completed, the maintenance of way and operating expenses must necessarily appear large.

The Louisville and Nashville system embraces 2 065 miles of road. Average total cost per mile $43 004, being about the average capital increase per mile of the English roads in the last fifteen years, thus:

	1870.	1884.
Average paid up capital per mile of all the railroads of the United Kingdom.....	£34 106	£42 486
Increase in fifteen years..........................		8 380

The reported increase of rolling stock will only account for about £1 000 of this increased capital.

A careful inspection of Table No. 45 will show the following results for work actually done, *i. e.*, the cost of transporting 1 ton or 1 passenger 1 mile on our well-constructed roads, such as the New York Central and Hudson River, Pennsylvania, Chicago, Rock Island and Pacific, Louisville and Nashville, main stem, etc., the cost compared with the English roads is about one-half for maintenance of way, repairs and renewals of locomotives and motive power, and from half to three-quarters for total operating expenses.

On the roads of low cost and inferior construction, with few exceptions, the average cost of these items for 1885 was less than on the English roads—varying from one-half to seven-eighths.

For comparison, let us select from Table No. 45 the London and North Western Railway, and the Pennsylvania Railroad Division of the Penn sylvania Railroad. Each of these may truly be said to be the most perfect and extensive of their respective types.

Comparin Total Operating Expenses.

NAME OF RAIL	of Re- enew- otives.	Total Cost of Motive Power.		Total Cost of Operating Expenses.	
	1 Ton 1 Passenger Moved Mile.	Per Train Mile.	Per 1 Ton or 1 Passenger Moved 1 Mile.	Per Train Mile.	Per 1 Ton or 1 Passenger Moved 1 Mile.
UNITED KIN $\pounds$ = \$4.80. d =	nts.	Cents.	Cents.	Cents.	Cents.
	....	15.26	......	62.40	......
Caledonian..............	092	15.92	.290	63.64	1.16
	102	16.26	.302	60.26	1.18
	....	17.32	......	64.42	......
Great Eastern............	096	17.88	.325	63.04	1.15
	092	17.12	.311	61.24	1.11
	....	15.20	......	59.68	......
Great Northern	083	15.50	.322	58.72	1.22
	086	15.24	.324	56.24	1.20
	....	15.14	......	59.92	......
Great Western	105	15.26	.277	60.04	1.09
	....	15 38	.285	59.34	1.10

TABLE No. 46.

London and North Western Railway, of England, compared with the Pennsylvania Railroad Division of the Pennsylvania Railroad, of the United States:

1884.	London and North Western.	Pennsylvania Railroad Division.
Total length of line operated	1 811	1 471
Aggregate daily trains over entire line	68	45
Average annual train mileage per mile of line operated	21 086	14 135
Average load of freight trains, tons	78	205
Average passenger trains, passengers	38	42
Average of all trains, tons and passengers	58	160
Average Cost of Transporting One ton, or One passenger, One mile.	**Cents.**	**Cents.**
Maintenance of way	.209	.103
Repairs and renewals of locomotives	.082	.044
Total cost of motive power	.271	.148
Total operating expenses	1.130	.530

From the preceding table it appears that the actual cost of transporting one ton, or one passenger, one mile on the London and North Western is about double what it is on the Pennsylvania, in maintenance of way, repairs and renewals of locomotives, motive power and total operating expenses. To this last item, for the London and North Western there should be allowed a large credit, as, owing to the average length of haul for freight being shorter on that road than on the Pennsylvania, the terminal charges are proportionately greater.

It may be said that this calculation is based entirely upon my plan for estimating the ton and passenger mileage, *i. e.*, the average charge of 1d. per ton per mile, and 1⅛d. per passenger per mile for ordinary tickets, and .4d. per mile for season tickets, including first, second and third-class.

For argument sake we can reduce all these prices one-half, and by making proper allowance for the difference in the price of labor and materials that constitute almost entirely the different items of operating expenses, the Pennsylvania Railroad will still be found to cost less.

Suppose we substitute in the preceding table for the Pennsylvania Railroad, the Knoxville branch of the Louisville and Nashville system. This can be considered a fair sample of the cheaply constructed American railroad. It runs through, physically, a very rough, sparsely settled country, offering no natural advantage for cheap railroading. The traffic is so small that it only justifies a total of ten trains daily. The entire average cost of constructing this road is $26 464 per mile—less than one-ninth of the average cost of the London and North Western per mile.

TABLE No. 47.

London and North Western Railway, of England, compared to the Knoxville Branch of the Louisville and Nashville System.

1884.	London and North Western.	Knoxville Branch.
Total length of line operated	1 811	171
Total annual freight and passenger train mileage per mile of line operated	21 086	3 515
Average load of freight trains, tons	78	122
Average load of passenger trains, passengers	38	39
Average load of all trains, tons and passengers	58	88
Average Cost of Transporting One Ton, or One Passenger, One Mile.	Cents.	Cents.
Maintenance of way	.209	.404
Repairs and renewals of locomotives	.082	.052
Total cost of motive power	.271	.239
Total operating expenses	1.130	1.069

Notwithstanding the small traffic and the cheapness of construction of the Knoxville Branch, the cost for moving one ton, or one passenger one mile, for maintenance of way, is only .2 cent more, while all the other charges are less than on the London and North Western Railway, the total operating expenses being as 1.130 to 1 069 cents or .061 cent less.

The returns or reports of the London and North Western for 1885 have not been received by me. In 1885 the Knoxville Branch made

large savings in the cost of maintenance of way, and consequently in operating expenses, comparing thus:

TABLE No. 48.

Cost of Moving one Ton, or one Passenger, one mile.	London and North Western, 1884.	Knoxville Branch, 1885.
Maintenance of way..................	.209 cents.	.248 cents.
Total operating expenses	1.130 "	.819 "

This table shows the cost of maintenance of way to be nearly the same, while the total cost of operating expenses is 27 per cent. less on the cheap than on the expensively constructed road.

Some persons state that the reason of the greater cost of the different items forming the cost of operating expenses, is owing to the greater number of trains running on a given mile of the English railroads. This is unquestionably the cause of most of the increase, but is it a good reason for it?

Can it be considered good practice to employ two men to do the same work that others are doing with less than one man? Is not this just what is being done now on the English railways, owing to the light freight and passenger trains that are run, requiring over two engines and two sets of men to do the same amount of work that the Americans do with one?

It is difficult to say what causes this great difference in the cost of maintenance of way. Undoubtedly the rigid and stiff rolling stock used on the English roads runs with more friction and wear and tear than the pliable bogie-truck used on the American railroads.

TABLE No. 49.

Comparative Cost of Transporting one Ton, or one Passenger, one mile, in Maintenance of Way and Motive Power.

No Reports for 1885 from the London and North Western have been received.	London and North Western. Average of Years 1883 and 1884.	Pennsylvania Railroad Division. Average of Years 1883, 1884 & 1885.
Maintenance of way..................	.206 cent.	.100 cent.
Motive power	.266 "	.147 "
Total	.472 cent.	.247 cent.
	.247 "	
Excess of cost...............	.225 cent.	

This excess is more than half of the total cost of all operating expenses of the Pennsylvania Railroad in 1885.

It cannot be said that the Pennsylvania Railroad has favored to any serious extent these two accounts at the expense of others, as the total cost of all operating expenses in 1885 was less than the aggregate of these two items on the London and North Western.

If this amount could be saved, it would, on the traffic of the London and North Western Railway, amount to an annual saving of about ($5 000 000) five millions of dollars. This estimate is based upon the prices actually paid. This saving would be still more largely increased if proper allowances were made for the difference in the price of labor and material used on the two railroads.

I conclude this paper with the last sentence in my first paper on this subject.

" For what *is* done in the United States, *ought* to be done in the United Kingdom."

DISCUSSION ON ENGLISH AND AMERICAN RAILROADS COMPARED.

Mr. Dorsey said that Mr. Bouscaren was mistaken in thinking that the author blames the English engineers for the great cost of the English railroads; he merely gave the facts as they exist, without blaming any one. Mr. Bouscaren, in common with many others, over-estimates the importance of land damages, right of way, and legal and parliamentary expenses in making up the total average cost of $202 227 per mile. The highest estimate given for the average cost of land per mile is $20 000; add to this the $16 000 (which is given by him as an example of excessive charges) as the average cost per mile of the Great Northern in parliamentary expenses. Take this as the average of all English roads, this gives:

Average cost of right of way and damages............	$20 000
" parlimentary and legal expenses......	16 000
Total per mile................................	$36 000

Leaving $166 000 as the average cost of construction per mile, which is very high. Considering the low price of labor and materials, the cost is much greater than ours, including everything.

Mr. Edward P. North presented figures obtained in reference to freights in England from the report of Sir Bernard Samuelson, made to C. M. Norwood, President of the Association of the Chambers of Commerce of the United Kingdom. Complaints having been made by some one in Great Britain that the freight charges were too high, Sir Bernard Samuelson gathered carefully this information in regard to rates on railways in Germany, Holland, etc., and compared the charges with those on the English roads. In the tables submitted herewith, the rates so obtained for the roads in Great Britain are compared with the present trunk line rates between Chicago and New York, which had been given to Mr. North by Mr. S. F. Pierson, of the Trunk Pool Commission. Attention was called to the fact that though the distance between Chicago and New York varied by different routes from 912 to over 1 100 miles, all the rates, being equal, are computed for a distance of 1 000 miles; and also the fact should be noted that the distance hauled here is much greater than in England, giving a larger divisor for terminal expenses; on the other hand, it may be noted that the volume of traffic is greater in England than in this country.

TABLE No. 50.

Showing Freight Rates on English and American Railroads.

All the rates are given in mills per ton mile. The pound is valued at $4.84.

		English.	Amer.
Pig Iron.			
Barrow to Sheffield	122 miles	14.5	5.
" Birmingham	161 "	16.	5.
Iron Wire, Packed and Unpacked.			
Birmingham to Coventry	19 miles	110. and 63.6	7.
" Manchester	84 "	49. " 30.	7.
" Liverpool	97 "	46.9 " 30.	7.
" London	113 "	50.3 " 32.4	7.
" Hull	122 "	46. " 32.	7.
" Glasgow	296 "	29. " 22.5	7.
Hardware.			
Birmingham to Manchester	84 miles	51.	12.
" Liverpool	97 "	48.3	12.
" London	113 "	50.5	12.
" Plymouth	222 "	41.	12.
" Glasgow	296 "	31.	12.
" Edinburgh	298 "	26.6	12.
Saws and Tools.			
Sheffield to Hull	53 miles	59.4	12.
Cotton Yarns.			
Manchester to Hull	92 miles	47.4	15.
" Newcastle	142 "	39.2	15.
Cotton Goods, Export and Home.			
Manchester to Liverpool	31 miles	53.2 and 82.	15.
" Hull	92 "	47.	15.
" Birmingham	84 "	61.*	15.
" Bristol	117 "	42.3	15.
" London	200 "	25.5 and 43.9	15.
" Exeter	266 "	39.7	15.
Woolen, Worsted and Stuff Goods.			
Bradford to Manchester	40 miles	87.	15.
" Birmingham	120 "	58.3	15.
" London	196 "	48.7	15.
" Glasgow	210 "	47.2	15.
Earthenware and China.			
Trunk Line Rates—China 15, and earthenware 7 mills per ton mile.			
Stoke to Birmingham	45 miles	53.7 and 77.	15. and 7.
" London	150 "	31. " 50.	15. " 7.
General Machinery, Export and Home.			
Leeds to Hull	51 miles	59.2 and 118.5	7.
" Newcastle	100 "	27.8 " 34.3	7.
Agricultural Machines (Iron), Export and Home.			
Banbury to London	78 miles	80. and 98.	7.
Bedford "	50 "	90.4 " 106.4	7.
" Liverpool	152 "	65.8 " 86.	7.

TABLE No. 50—*Continued.*

		English.	Amer.
SUGAR.			
Liverpool to Manchester	31 miles	85.8	5.
Hull to Sheffield	53 "	53.	5.
London to Northampton	67 "	39.	5.
" Sheffield	162 "	22.4	5.
Greenock to Newcastle	186 "	17.	5.
COTTON.			
Liverpool to Manchester	31 miles	56.	5.4
WOOL.			
Liverpool to Manchester	31 miles	71.	9.
TEA.			
Liverpool to Manchester	31 miles	84.5	15.
ORANGES.			
Liverpool to Manchester	31 miles	71.6	12.
TALLOW.			
Liverpool to Manchester	31 miles	61.7	6.
BACON AND HAM.			
Liverpool to Manchester	31 miles	71.	6.
GRAIN AND FLOUR.			
Liverpool to Birmingham	97 miles	31.	5.
Bristol "	94 "	20.	5.

The first price, where two are given in the English rates, is for goods to be exported.

The American rates given in this table should be multiplied by $\frac{112}{100}$ for exactness of comparison, because the English rates are on gross and the American on net tons. For example, the rate as given from Liverpool to Birmingham, 97 miles, on grain and flour, is $3.01 per gross ton, and the rate as given from Chicago to New York, 1 000 miles, is $5 per net ton and $5 60 per gross ton. It will be noticed that the average of the American rates here given are 8½ per cent. of the average English rates.

In this connection it would be of interest to know if the British rates are ever "cut," and to what extent freight cars are allowed to stand on private side tracks for the convenience of shippers and consignees. As has been shown here, railroads sometimes allow consignees to retain freight cars for a week or more without extra charge.

In England getting a railroad charter is a very difficult and expensive proceeding. It requires parliamentary proceedings, with a high class of parliamentary engineers and lawyers, which we understand are expensive luxuries; the result is that the few railroads in the country have in reality a monopoly; they have formed a strong pool among themselves; they do not compete in prices. The general public pays for this. Here we get low rates because by our general railroad laws competition is more active than in any other country. He thought that the rates here were, taking them all through, not more than one-half, or perhaps one-third of those in England, which are the highest in the world. He also thought that we have better railroad men than in England; that our locomotives run more miles and haul more freight at a smaller cost for

repairs. We put comparatively a small capital in our roads, and, as Mr. Dorsey says, it is profitable to open a road on a small expenditure of capital, improving it afterwards when the rates will be lower. He called attention to the fact that the rates given for trunk lines in the table are the published American pool rates; nobody supposes that the companies ever get more than these published rates; they are sometimes accused of taking very much less.

T. C. Clarke, M. Am. Soc. C. E., said that a comparison of the cost of motive power on the elevated lines of New York with that on the underground lines of London may be interesting, as another example of the correctness of the position taken by Mr. Dorsey.

The statement is taken from the report of the Manhattan Company to the State Engineer for 1884, and the reports of the Metropolitan District lines of London for the same year. The money is given in English currency in both cases.

Receipts of the London underground lines were £1 012 000; expenses, £434 000; leaving net, £578 000. Number of passengers carried, 114 500 000. Cost per passenger $\frac{9}{10}$d.

Receipts of New York elevated lines, £1 345 000; expenses, £777 000; leaving net, £568 000. Number of passengers carried, 97 000 000. Cost per passenger $1\frac{92}{100}$d., or more than double that of the London lines.

Hence most persons have assumed that the London lines were worked more economically than the New York elevated lines, all of which confirms the truth of the wise man's remark: "There is nothing so fallacious as facts—except figures."

The truth is this: The trains of the New York lines, owing to the light traffic on the Second and Ninth Avenues, and to the heavy traffic of morning and evening being in one direction only, have to travel four times as far as the London trains do, owing to their traffic being concentrated all around a circle and inside of it.

The train mileage of the London lines for the year above given was 1 647 000 miles, while that of the New York lines was 6 057 000 miles. The receipts per train mile run on the London lines was 13s.; cost, $5\frac{21}{100}$s.; net, $7\frac{79}{100}$s.

The train mileage on the New York lines was 6 057 000 miles; receipts per train mile, $4\frac{1}{2}$s.; cost, $2\frac{56}{100}$s.; net, $1\frac{94}{100}$s. Hence it appears that while the receipts per train mile of the London lines was nearly three times as much as on the New York lines, the cost per train mile (which is got by dividing the total working expenses by the total train miles run) was less than one-half.

The returns also enable us to state the cost of motive power, only omitting cost of maintenance of roadway and stations, and of general expenses.

* Also M. Inst. C. E.

The London trains cost 3s. 4d. per mile run; the New York trains 1s. 9d. per mile run.

The economy, not only of motive power, but of all expenses of the New York over the London lines, is due to the use of lighter and better designed rolling stock, at slower speeds; as well as—possibly—to better management.

The London underground trains weigh about 140 tons, carry 300 to 330 passengers, and run 18 miles per hour. The New York elevated trains weigh about 80 tons; carry, seated and standing, an average of 300 passengers, and run 13 miles per hour.

The cost of maintenance of the "flimsy" iron structures upon which these trains run, is much less than that of the "solid road-bed" of the underground lines.

Finally, if the cost of motive power and train service on the New York lines was as great as that on the London lines, the receipts would not be sufficient to pay running expenses.

WALTON W. EVANS, M. Am. Soc. C. E., M. Inst. C. E., said, by letter, quoting from Alexander Von Humboldt, that "the chasms which divide facts from each other are rapidly filling up; and it has often happened that facts observed at a distance have thrown a new and unexpected light on others nearer home, which had long seemed to resist all efforts at explanation."

Mr. Evans, continuing, said that the paper of Mr. Dorsey is one that deals with a subject of vast importance to railway interests. This subject was handled by Dr. Lardner, more than a third of a century ago, with marked ability, in a work entitled "Railway Economy." Then this great moving power was in its infancy, and but hundreds of millions of money invested in it. Now it has absorbed thousands of millions, and become one of the chief factors in the progress of nations throughout the world. Mr. Dorsey has rendered a signal service to the railway interests of any country by comparing the systems of the two countries which were leaders in this great enterprise, and analyzing the results, first, of cost, and then of operating, through which results could be arrived at and reforms instituted when required. Mr. Dorsey took on himself a labor of no small magnitude when he sat down to write his paper and bring order out of the chaos of interminable rows of figures. To write a sermon, an essay, or an editorial for a morning paper is mere child's play to tackling the figures that make a table of comparison, when those figures amount to millions of units, and when the hundredth or thousandth part of a unit plays an important part in the result sought for. We have Mr. Dorsey's paper before us, and it now remains with us and our friends, the engineers on the other side of the Atlantic, to examine it lynx-eyed as to the methods by which he arrived at his results, and the correctness of his figures; if these are not

correct his results fall to the ground, and lose their influence to become factors in working out railway economy. Mr. Dorsey calls on all engineers to examine his figures, and if they can find errors to point them out. A year and a quarter have passed since his paper was read, and, as far as the writer knows, his figures remain unchallenged. In England, the writer has heard that his figures have been met by assertions, and no proof given or offered. Engineers have nothing to do with mere assertions. Leave them to lawyers, whose business it is to befog a jury and make black appear to be white. It has been told to the writer that a member of the Institution of Civil Engineers asserted at the Institution recently that "American locomotives were short lived," and that they were "cheap and nasty" (a questionable expression, but one much used in England). Another member of the Institution, in alluding to American locomotives, said "they did very well on the rough roads of America, but soon wriggled themselves to pieces if put on the good tracks of England." This man was, no doubt, sincere and conscientious. It is astounding to see what people, not lunatics, will believe when they wish to believe it. A ship that can stand up gallantly in a rough sea, in howling storms, is not going to pieces in a smooth sea, when urged along by gentle breezes. The author of the first remark, if properly reported, should recollect that it is a naughty thing for a man living in a glass house to throw stones. He was the engineer and contractor for two narrow gauge railways at Toronto in Canada, and furnished the rolling stock, all built in England. His brain must have had visions of that rolling stock passing before it when he applied the words "cheap and nasty" to American locomotives. In 1874, Mr. Higginbotham, the Engineer-in-Chief of the English Colony at Victoria in Australia, in his report to his government (a parliamentary document) says of this rolling stock (in describing the Nipissing, 88 miles, and the Toronto, Gray and Bruce Railways, 190 miles long): "The two lines to which I have referred were stocked at first with engines, carriages and wagons built in England, which proved complete failures, and have been replaced by American engines and cars; these are found to work well."

"The rigid wheel base of the English rolling stock had been tried and condemned." "The Master Mechanic (Locomotive Superintendent), who is an Englishman, told me that he preferred American to English engines and rolling stock for railways in Canada." Living in a glass house like this one, that was clearly "cheap and nasty," it does not come with good grace for this gentleman to throw stones at American engines. Before taking Mr. Higginbotham out of Canada, let us revert for a moment to what he says in his report on the Grand Trunk Railway, an English line intended to be a model one, and equal to the best in the world (it ought to be, it cost enough). Mr. Higginbotham says: "English engines and rolling stock were tried but had to be abandoned, and the American type adopted." The writer has a letter of Mr. Ross,

the Chief Engineer of that Railway, in which he says (after alluding to his English model engines being altered to American patterns): "On the breaking up of the frost we never could keep the English engines on the track, except at a slow speed which defeated our object."

In reviewing this paper of Mr. Dorsey's, and looking at the tremendous differences he makes in comparing the railways of England with those of America as to economy in operating, it is clearly the locomotive we must look to as the prime factor in working out this problem, and getting at the astounding results put down to the credit of the American system. There is no use in meeting a question of so much importance to the world with sneers or assertions that American railways are "cheap and nasty," or say that their engines are "gingerbread peacocks," that "wriggle themselves to pieces on a good road," and that "they are here to-day and gone to-morrow." Assertions are not arguments, we give facts and figures, and we wish them controverted by facts and figures, or their correctness admitted. The splendid results shown in Mr. Dorsey's paper, when comparing the American with the English system, appear at first sight to be entirely the work of the locomotive. The writer begs to say that a part of these results belong to the American system of cars; long cars resting on two four-wheeled bogies having chilled cast-iron disk wheels, the safest and most economical wheel ever put under a railway car. This has been admitted by eminent English engineers, among them Sir Douglas Fox, Cor. M. Am. Soc. C. E., in his paper on the Pennsylvania Railroad read at the Institution of Civil Engineers. Another point of merit in the American car is the use of oil in the journal-boxes instead of grease. Mr. McConnell, Locomotive Engineer of the London and North Western Railway, tried a set of six American boxes on the tender of a locomotive, and six English boxes at the same time, for four months, and showed that while the American boxes averaged a cost of 1½d. a day, the English boxes cost 9d. a day. See paper read by Mr. Hodge before the Institution of Mechanical Engineers, October 27th, 1852, at Birmingham. Let any one apply this little economy to a rolling stock of 50 000 cars and 2 500 locomotives and see if it does not amount to something in a year. The greatest merit the American car has, when compared with the English, is its being mounted on eight wheels, while the other rests on four wheels only. In running these latter, the whole car and its load feel every inequality of the road, and oscillate in the direction of its length, and by so doing render null a part of the power of the engine. In the other case the bogies feel the inequalities of the road, but the body and the load do not, and run with great steadiness. In corroboration of this the writer quotes from a report of J. Boyd Thompson, Manager of the Northern Railway of Buenos Ayres, to his Directors in London, dated June 27th, 1867. "Our stock of carriages consists of ten made in England and two in the United States. During the past ten months

repairs to English carriages amount to $4 086 currency each, whilst during the same period the American carriages have cost nothing for repairs, and are at present in better condition than those made in England, though they have been in constant use since the line was first opened. I may also remark that their chilled-iron wheels scarcely show any perceptible wear. The American carriages are in every respect better and more comfortable, requiring less than one-half the power to propel them that is necessary for the English." It has been proved that the English carriages are much more injurious to the permanent way and works, and likewise in proportion more injurious to themselves than those of American make. "I most strongly recommend the American model carriages and wagons. They cost less, are not so expensive to keep in repair, run easier, and cause less wear and tear on the permanent way." There, that's pretty liberal coming from a Scotchman. He clearly did not think the American cars "cheap and nasty."

Before leaving the Central Argentine Republic, the writer desires to put on record a line or two about the Central Argentine Railway, built by Messrs. Brassey, Wythes & Wheelwright, of London. They sent to the writer for the whole rolling stock required. The carriages and cars asked for were sent out. The locomotives could not be sent, as the engine works were all engaged by the Government, as we were in the midst of our civil war. Some time after, when this railway was nearly completed, Mr. Wheelwright, in writing from Rosario, said, in a lamenting tone: "You would have saved us a mint of money if you could have sent us American engines." It is clear he did not think American engines "cheap and nasty."

This railway, 243 miles long, was over the pampas, and nearly level and straight for the whole distance.

This superiority of the American railway rolling stock is not a new subject for discussion, as it has been talked about and written about ever since the earliest dawn of the railway era. Its merits were soon talked of in England, and, as early as 1837, Norris & Son, of Philadelphia, were called on to build seventeen locomotives for the Gloucester and Birmingham Railway. They gave satisfaction (it was before the time when American engines were called "cheap and nasty"); other orders followed, but the builders in England grew excited and obtained from the Lords of the Treasury an order prohibiting the importation of locomotive engines into England. The history of this is to be found in the *United States Magazine* for June, 1855.

In 1849, Mr. F. Passavant, an English engineer, came to the States to study the American engine. On returning he published a series of articles on the American locomotive in the *Glasgow Practical Mechanics' Journal*, Volumes 2 and 3, which are interesting. He appears to have grasped at once all the main points of merit in the American engine, and admits them as freely as any American could do. He compares an

English slab-frame and an American bar-frame, and shows that the latter is practically and scientifically the best in proportion of 4 088 to 15 232. He describes the merits of the bogies and the use of outside cylinders, and gives his reasons. He says: "In their frame the Americans have successfully attempted to give steadiness, stability and durability to their engines. The above three virtues are solely dependent on a sound, well constructed frame."

"On most English railways, experience has shown that the resistances on a level are twelve pounds per ton. In the United States the resistances appear to be not more than three pounds per ton." [Extract from Mr. Isaacs' paper on "Locomotive Power," in *American Locomotive Engineer*, December 3d, 1858.]

In 1880, Mr. Higginbotham, Engineer-in-Chief for the Colony of Victoria, Australia, in a letter to the writer says: "The Rogers' engines you sent us have done and are still doing splendid work. They are hardly ever in the shops for repairs, are as easy to ride on as a first-class carriage, and are certainly lighter on the permanent way than any other engine which we have. If they had been built here their merits would have been loudly proclaimed, but as they were not, nothing is said about them, and so profound is our provincialism, that any one who published their merits would almost surely make himself unpopular." In 1877, Mr. Higginbotham sent the writer a full account of all the engines on the Melbourne and Woodend Railway, 97 miles long. This shows that the American engines averaged $2\frac{1}{10}$ pounds less fuel per train mile than the English engines. They were built for passenger service, but as soon as they got them they were put on goods service. These engines have recently been put in repair and are reported as the best engines in the colony to run the new express from Adelaide to Melbourne. Before Mr. Higginbotham came here in 1874, a son of the first Governor of Victoria, in a letter to the writer from Melbourne, said: "Mr. Higginbotham has started by order of this government to visit the railways of the United States. He has his mind made up against all things American."

In 1854–55, the writer directed the building of a branch of the Copiapo Railway, in Chili, for a London company. It ran to the rich silver mines in the district of Chañarcillo. It had a summit of 4 467 feet, the highest then known. It had gradients of 5 per cent., and curves of 500 feet radius. The engines were built in England, had bogies and three pair of driving wheels. In discussing "Steep Inclines and Sharp Curves" at the Institution of Civil Engineers, these engines were referred to as giving great satisfaction on account of their having bogies. Now, the fact is these engines sunk the entire capital of that company in nine years, and they had to sell out to the Copiapo Railway Company.

In a private letter of Mr. P. Gould, the Locomotive Engineer of the Copiapo Company, to Mr. Hudson, Engineer of the Rogers Loco-

motive Works, he says: "Your two last engines are working successfully on the grades of the Copiapo Extension Railway. There was much talk about the fuel burnt. I was afraid the men might be mistaken about the weight of the coal used, and did not say anything to you about it. Now, however, after three months' experience, we are satisfied that we can haul 50 per cent. more load with 20 per cent. less fuel per mile than the English engines." This is much more than I expected. "The difference between these engines is that the old engines have ruined the English company who owned the line before, they having sunk the entire capital, while our engines are making it a very good business for this company. It is true that we bought the line for a very low price; but even at the price it cost the other company it would have paid a fair interest."

In 1869, Mr. Zerah Colburn, by request, read a paper, No. 1230, before the Institution of Civil Engineers, on "American Rolling Stock." In a letter to the writer he asked for some data on the subject. The writer sent him a good deal, and then told him: "You will not dare to get up in the presence of any body in London and give this as I give it to you, for your bread and butter is, in a measure, mixed up in this matter." Mr. Colburn did not give the data I gave him, but contented himself with saying that the chief differences between American and English rolling stock was a matter of "toilet." In his paper he describes running a test train over the entire line of the Erie Railway to get at the engine power required on each division. In the discussion that took place on this paper Mr. Berkely doubted the correctness of Mr. Colburn's figures, as he thought no engine ever made could give such results.

The *Engineer*, of London, in speaking of engine trials made under the direction of the writer on a government railway in Chili, in 1859, said that such results had never been obtained by any engine, and never would be. In a discussion on the economy of fuel at the Institution of Civil Engineers Mr. Lloyd, in referring to the Chili trials, said that "the English engines showed the greatest economy, as proved by Mr. Evans' experiments." The fact is that these trials proved the reverse, and Mr. Lloyd should have known it, for the locomotive engineer of his road was on the engines all four days of these trials, taking notes, which were like mine.

The Tongoi Railway, on the coast of Chili, has in it, on the summit division, gradients of 1 in 20. This road was originally stocked with engines and cars from England. It is owned chiefly by Englishmen. In 1870, Mr. Green, the Manager, sent to the writer for some American engines to work his steep inclines. After these engines were sent out he was asked to give some relative data in reference to the performance of these engines with the English engines. He wrote, "I cannot give you what you ask for, as I am now doing all the work on the summit

division with the Campanil, one of your engines, where I formerly occupied the services of two."

Mr. J. C. Hoadley, a mechanical expert of high standing, was sent to England in the midst of our civil war, to procure guns for the defense of Boston harbor. He was delighted with all he saw, Scott Russell and others having been very kind to him, showing him the railway works. He said to them, "Gentlemen, this is all very magnificent, but it is also very extravagant. We cannot afford such expenditures as I see here on all sides. If by some great convulsion of nature we in America were to lose all our rolling stock, and you, in the generosity of your dispositions and kindness of heart, were to offer to replace it as a gift, we could not afford to accept it."

In the centennial year, Mr. Massey Bromley, of the Great Eastern Railway, was sent here to study American locomotives. The writer gave him letters of introduction. After spending three months in the study he came for, he came to the writer's office and said, "I am delighted with all I have seen, and am going home to build American locomotives." The writer said, "Will you build American driving wheels?" He said, "Yes, as I find them better and cheaper." Being asked if he intended to build American frames, he said, "No; your frames are too expensive, we cannot afford them." The writer replied, "You will not have an American locomotive, for the frame is the backbone, one of the chief points of merit on the whole machine."

In 1877, the writer sent two patterns of engines, by order of the government of New Zealand, to their Locomotive Engineer, who was in charge of the motive power of more than one thousand miles of railway. He, during two years, in many letters, spoke in the highest praise of the merits of these engines, saying, "They are doing wonderful work; day after day they are turned out to run the express at thirty miles per hour on forty-pound metals, and never a hitch takes place. They keep time and work cheaply, and the men who drive them all maintain that they are the best engines they have ever been on. We are running the American engines imported for the Rakia and Ashburton Railway, and find them the most steady and smoothest-running engines in the country. I have much pleasure in informing you that the Baldwin engines are doing first-class work. About ten days ago, one of these hauled the heaviest train ever moved by one engine in this colony. It consisted of one hundred and eight wagons, loaded, and was estimated to weigh one thousand tons. The train was within one hundred feet of half a mile in length; speed, twelve to fifteen miles per hour; coal, native lignite. These engines are making a name for themselves. I should not be surprised to see American engines entirely adopted in this country. The Rogers passenger engines work splendidly. They are making each forty thousand miles per year. The more I see of American engines the more I like them. In the long run, the Ameri-

can engines will prove their worth to the most prejudiced mind. I used them on all the bad roads. They run over roads that would destroy our heavy English engines in three months."

The standard gauge of New Zealand is 3 feet 6 inches.

Mr. James Hall, an English engineer of great ability and standing, director and manager of the motive power of all the government railways of Chili, has been ordering American locomotives for about twenty-five years. In writing for more engines, in 1882, he says: "You will notice that I recommend more powerful engines than the old 14-inch cylinders. On this section we have long grades, and a heavy traffic always up. Our passenger trains consist of twelve American coaches (equal to twenty-four English coaches). It is only just to the old engines of the class Tano, cylinders, 14 by 24, wheels, 63 inches, to say they have done their work admirably, and are as good and as economical as you will find in any part of the world. The Tano ran nearly one hundred thousand miles without requiring any repairs worth mentioning."

Mr. J. L. Stothart, a well-knnown English engineer, who has been connected with railroad building in England, and who is a member of the Institution of Civil Engineers, came to this country in 1883 to see our railways and the machinery used in working them. On his way home he wrote a letter to Mr. Robert E. Pettit, M. Am. Soc. C. E., Manager of the New Jersey Division of the Pennsylvania Railway, thanking him for permission to ride on the engine, in which he says:

"*Freedom from Oscillation.*—In this respect, and the principal one, I wished to satisfy myself upon, your engines leave nothing to be desired. They are absolutely steady at the highest speed, and upon carefully gauging the framing with the rail, I could never detect any oscillation on a straight track, whatever speed was obtained. On the journey from Trenton to Jersey City on No. 260, we ran three consecutive miles in 58 seconds each, and two miles in 1 minute 58 seconds. There was no swing on the engine at this speed, and I do not think any English locomotive at these speeds would have been so free from oscillation.

"*General Working Arrangement.*—In this respect your engines are perfect. All the handles are brought to one focus, and the introduction of steam reversing gear demands no manual exertion on the part of the drivers. The engines run nearly as comfortably as your carriages."

In the London *Engineer*, of October 1st, 1858, the editor says: "Mr. Robert Stephenson stated, while in America, that the engines in that country were better than those of English build, while the same gentleman, to the knowledge of the writer, has reiterated the same opinion within the last ten days."

In September of last year, Mr. D. Banderali, engineer of the motive power of the Northern Railway of France, came here to study the American locomotive, and in May, in a French review on railways, gives an account of some of his observations. He says he "was struck by

the fact that the number of locomotives was small in proportion to the mileage of the road and the train mileage, and also by the fact that so small a portion of the engines were undergoing repairs in the shops; also by the smallness of the stocks of materials used for repairs. The repairs of the locomotive are reduced by the solidity and simplicity of their construction. One remarkable fact prevails everywhere, and whatever the system adopted, I have found the engines in a perfect state of repair, and the motive power service as satisfactory as possible.

"It is not without difficulty that the American engineers have succeeded in modifying established customs. Their personal intervention, energetic, patient, persistent, at the same time adroit, action, has overcome all opposition." Longer quotations from this paper might well be given, it is all very interesting.

In 1883, the Minister of New Zealand ordered twenty locomotives in England, sending drawings and specifications. At the end of eighteen months he heard of two being finished and ready to ship. The Agent-General informed him that as these engines weighed each ten tons more than the contract called for, he had better strengthen all his bridges, or they would break them down. Wishing engines badly, he ordered twelve of the Baldwin Locomotive Works in Philadelphia. They were all completed and shipped in three and one-half months. The Minister then said in his report to Parliament: "The best of this business is that these engines will cost, delivered here, £400 each less than the English engines."

In 1852, Mr. Edward Woods, a distinguished engineer of England, at present President of the Institution of Civil Engineers, was called by the London and North Western Railway Company to examine and report on the causes for the very excessive amount of fuel consumed on the Southern Division over that used on the Northern Division. After great labor during more than a year, and after equating the cost of everything that could be equated, they found a large amount unaccounted for, except by the use of large inside-connected engines on the Southern Division over the amount burned by the smaller outside-connected engines of the Northern Division.

Mr. Woods did not find that it was the largest amount of fire surfaces in an engine that always produced the largest amount of steam, nor did he find anything to prove the inferiority of the outside-connected engines of the Northern Division on a single point, nor did he find that inside-connected engines were always steady running engines.

In a recent letter to Mr. Woods, the writer mentioned having read Mr. Stroudley's paper on his new design for engines, and said it looked to him as if they were going backwards in engine construction in England; and he thinks from the remarks made by W. H. Mills, of the Great Northern of Ireland, in the discussion, that he supports him in his views. To build engines with crank-axles makes the center of grav-

ity exceptionably high, and then to place the driving wheels as leading wheels, and claim these points as merits in engine construction, is to American engineers incomprehensible.

The London *Railway News*, of November 16th and 30th, and December 7th, 1872, and February 22d, 1873, published some very interesting statistics of comparisons between four English and four American railways. They are too long to go into a paper of this kind. One of these comparisons may be mentioned. After stating that the business of the New York Central Railway was grèater than that of the London and North Western Railway, it shows that the former is worked by $\frac{50}{100}$ of a locomotive per mile of road, while the latter occupies the services of $1\frac{44}{100}$ engines per mile of road.

The writer has now mentioned the opinions and writings of many clever engineers, most of them Englishmen, and has probably given a hundred times more than is necessary to convince any unprejudiced mind that there is not only merit, but great and wonderful merit in the American engine. But if their writing had extended to a thousand times as much, it could not have convinced any one of those who are blinded by prejudice and who are skeptics as to anything good having originated in America. The writer is inclined to think that if that great man, George Stephenson, that great master of mechanical instinct, should come up from the tomb to see the railways and judge of the progress that had been made, by the money results, and comparisons in different countries, particularly those of England and America, he would shrink back in holy horror.

It is generally believed that a first-class railway in all its appointments should be able to carry vast amounts with regularity and speed, without accident and without straining any of its parts. Let us glance at a few things that have been done in America, and see if they have ever been matched in any other country.

In the Centennial year a train was run from New York to San Francisco, a distance of 3 317 miles, in 83 hours and 27 minutes actual time. This is nearly forty miles per hour for the whole distance. This train passed over four mountain ranges, one with a summit of 8 100 feet. On the Pennsylvania Railroad Division this train was run at a speed of 43½ miles an hour crossing the Allegheny Mountains, total distance being 439½ miles, and without making a stop. Mr. Howard Fry, an English mechanical engineer, Locomotive Superintendent of the Philadelphia and Erie Railroad, October 27th, 1877, ran a train of 100 eight-wheel cars loaded with coal oil and grain, weighing 2 201 tons (2 240 pound tons); length of train, 3 127 feet; speed of train, 10½ miles per hour; engine No. 41, cylinders 20 inches by 24 inches; weight on drivers, 88 000 pounds; road approximately level. This engine ran 26 trains in this month, with from ninety to one hundred and six cars in each train.

The Reading Railroad of Pennyslvania, which transports much the largest tonnage of any railway in the world, in 1885 carried as follows:

Passengers carried..........................	23 531 057
Coal carried in 2 240 pound tons............	12 530 594 tons.
Merchandise carried in 2 240 pound tons.....	7 493 510 "

The coal trains in summer are made up of 125 cars, and in the winter 115; average coal carried per train, 800 tons. A train on a branch of this road to New York, May 9th, 1884, ran 10 consecutive miles at an average of 75 miles per hour; work of this kind could not well be done by railway machinery that was "cheap and nasty."

On August 18th, 1886, a special newspaper train, No. 11, was run on the New York Central Railroad from Syracuse to Buffalo, $148\frac{7}{10}$ miles, at average speed of $65\frac{6}{10}$ miles an hour. On one section of ten miles the speed was 75 miles per hour. This engine had made her regular trip of 300 miles the day before, and did the same the day after.

Mr. Dorsey, in closing the discussion, said that Mr. C. E. Goad was very much mistaken in saying that the English passenger cars, by means of their side doors, can be unloaded and loaded in one-third the time that the American cars can through the two end doors.

Mr. Dorsey had personally taken the time of 531 stoppages on trains running into and in London, and 342 stoppages on trains on the four elevated railroads in New York. In all cases all stoppages that were prolonged by block signals, loading baggage or other causes, not caused by loading or unloading passengers, were rejected. The average of the 531 London stoppages was thirty-three and one-third seconds, the average of the 342 New York stoppages was eleven and two-thirds seconds—nearly one-third.

On the London roads the shortest average stoppages were made on the Metropolitan Railway. Theoretically, eight or ten persons should be able to leave or enter a car by one door quicker than fifty persons can by two doors; practically it is not so, as much time is lost by the passengers in finding among the six kinds of carriages on the London trains, the particular kind he or she wishes to ride in. After this is found, much more time is lost in opening doors and looking for a seat, whilst in the American cars there is only one class or kind, the passengers can enter by any door and find seats after the train is in motion.

He considered that Mr. Goad's remarks about lavatory conveniences on the cars used in the United Kingdom were very misleading. It is true some very few of the first-class carriages have water-closets. The Board of Trade Reports for 1884 show that only five per cent. of the whole travel of the United Kingdom was first-class. It is safe to say that not one per cent. of the first-class carriages used there have these conveniences, thus giving this great comfort to only about one person in every two thousand. This is very hard on the majority of travelers,

who have no other fault, except being poorer than the few richer or more privileged ones, nature giving to all alike the same necessities and requirements.

Mr. Dorsey fully agreed with Messrs. Collingwood and Shinn that all crossings in populous sections should be either above or below the level of track, whether at stations or any other place. In his paper he advised that laws should be passed compelling this to be done. He would advocate passing laws obliging all crossings, whether for vehicles, animals or foot passengers, to be either above or below grade in all counties or townships where the population averages over forty persons to the square mile.

Few persons have traveled more in the United States and England than himself, and after all this experience he is a firm believer in our check system for baggage.

Recently the London and North Western Railway made arrangements to check baggage from England to New York. Last month he had his baggage checked from his apartments in London to New York by this system, with very satisfactory results, as it enabled him to stop over between London and Liverpool without being troubled to look after his baggage, which he found all right on the New York dock. The railway company gave a slip of paper instead of our brass check. A receipt was given for the baggage when delivered in New York.

In regard to Mr. Goad's experience with his baggage, the remedy is very simple. If he or any one else prefers the English system, they can easily follow it here. There is no law obliging them to patronize the baggage expresses or transfer companies, all are at liberty to follow the English system if they prefer it, and take their baggage in a carriage to and from our railroad stations.

Heretofore all the discussion on the check system has been from the travelers' standpoint, as effecting his comfort and convenience. In the opinion of the author, the English railroad companies are more directly interested in this than the passenger, as by adopting it they could decrease their station expenses largely. He had many times counted over forty porters engaged in loading the baggage at one time, while at the same time many others were occupied on other platforms, especially in unloading the baggage from arriving trains. There must be in some of the large stations in England several hundred porters thus employed. Over eighty per cent. of these could be dispensed with by adopting our baggage check system, as most of the work they perform is done in the United States by the baggage express companies without cost to the railroads. It is true the porter's pay is very small, about 18 shillings ($4.37) per week, but in the aggregate it must be quite a respectable sum, and of sufficient importance to save.

In reply to Messrs. J. F. Crowell, M. N. Forney, A. M. Wellington, and W. H. White, Mr. Dorsey stated that it is absurd to compare the

cost of train miles in the two countries, owing to the American train averaging so much heavier loads than the English. For example, on the Pennsylvania Railroad Division the average load is three times larger than it is on the London and North Western. In comparing the cost per train mile the average load must be considered, or the comparison is false and misleading.

Mr. Dorsey again repeated that the English railroads make no return of the ton or passenger mileage, nor do they separate the cost of freight or passenger traffic.

He had made a great many inquiries in different places; the prevailing rates over different roads were ascertained; and then, by taking the percentage of each class of passenger and freight, the rates, as stated on page 16 were adopted.

Since they were first published and discussed, eighteen months had elapsed without their being disputed in any way; but, on the contrary, they have been confirmed from many reliable sources. For example:

The *Engineering*, of London, of August 20th, 1886, page 187, in speaking of "British Railway Administration," says:

"The average receipts from goods traffic in 1885 were only about 2s. 9d. per ton, and if we reckon that the average ton-mile rate was only 1d.—although it is certainly something more—the average length of lead for goods traffic would come out as thirty-three miles. * * * The train-mile receipt is not a function of the rates and fares so much as of the weight of the train, or rather of the live load carried, and if the English railways will persist in carrying loads of 50 to 100 tons, where they might just as easily carry three or four times that load with very little increase in the main items of working cost, they must expect not only a low range of train-mile receipts, but a low range of dividends as well. * * * And each passenger travels a distance of six miles."

This latter worked out, makes the average passenger fare per mile somewhat greater than the author's estimate, showing that he is conservative in his figures.

The preceding is an unequivocal indorsement of the author's estimated average freight and passenger rates, and also of the estimated train load based upon his rates. It also confirms the views of the speaker as expressed in his different papers, that the English train load in freight and passengers is too small for economical working, and by making the loads much larger the rates could be lowered, or the dividends increased.

Mr. J. S. Jeans, the able statistician of England, says, on page 181 of his "Annual Statistical Report" to the British Iron Trade Association for 1884:

"The average ratio quoted for the transport of iron ore and coal in England could be varied either upward or downward according to the

distance or lead. But if the average rate is taken at 1d. per ton per mile, which is probably as near the mark as we can get, instead of 1.02d. as shown is the average of iron ore."

If the average freight charge per ton per mile on iron ore is 1.02d., and on iron ore and coal 1d., the author's estimate of 1d. average charge per ton per mile on all freight is much too low. If it is too low, the estimated train loads in England are too large, and should be reduced.

Sir B. Samuelson, M.P., in his pamphlet, "Railway Goods Tariffs," 1886, gives a long list of freight charges on many different articles between many different points. These charges have been ably analyzed by Mr. E. P. North, M. Am. Soc. C. E., in his discussion on this paper. See page 93. These rates more than confirm the author's estimates.

In the evidence of Mr. Alexander Meadows Rendel, C.E., in the "Report of East India Public Works," printed by order of the English House of Commons, on page 502 he says:

"Assume, also, that the average charge in Great Britain and Ireland for carrying a passenger 1 mile is $1\frac{1}{16}$d., and for carrying a ton of goods (including minerals amongst goods) $1\frac{1}{4}$d. per mile. I am obliged to assume these figures, because no English company either publishes its average charges, or states its charges in such a way as to allow the averages to be ascertained. The object here is to assume averages favorable to the English lines; that is to say, rather below than above the fact. And I am quite satisfied that in taking $1\frac{1}{16}$d. for passengers and $1\frac{1}{4}$d. for goods I have done so."

These last are the identical figures arrived at and used in the paper under discussion, as will be seen at page 16.

Mr. Dorsey had seen letters from some of the principal railroad managers of England in reference to his paper, but none deniek the correctness of his ton or passenger mileage estimate.

In answer to all remarks about the cost of "repairs and renewals of locomotives," cost of "motive power," "maintenance of way," and "total cost of operating expenses," he referred to his Tables Nos. 45 and 51 where thirteen of the principal railroads of the United Kingdom are compared with fifteen representative roads of the United States, all this data being from official sources, except the passenger and ton mileage.

Backed by this strong corroborating evidence, he felt that he could very properly repeat from his first paper: "He hopes that the railroads which are so largely interested in this question, will promptly replace his estimates of ton and passenger mileage by their official figures. Until this is done he claims that these figures should be accepted as correct."

APPENDIX.

Nearly two years have passed since the first of these papers was read and published, during which time they have been much discussed and commented upon, yet no one has denied any of the facts stated, whether they were taken from official data or based upon my estimate of passenger and ton mileage. As these have not been disputed, but have been confirmed by many reliable authorities, they must therefore be considered proved and correct.

Since the first publication of these papers, the annual reports of the railroads for two more years, 1885 and 1886, have been received, analyzed and compared. They all fully confirm and emphasize the statements made in the first papers.

Table No. 51 is similar to No. 45, but is enlarged, and has the comparisons for one more railroad year added. For reference and comparison, the cost of transporting one passenger and one ton one mile on some American railroads has also been added.

Passenger Traffic.

In comparing the cost of passenger traffic on the English and American railroads, it must be borne in mind that the cost is the average of all passenger traffic, which, on the American roads, is practically all first-class, while on the English roads only about five per cent. is first-class, seventy-five per cent. being third-class.

There is no comparison in the comfort in traveling in the poorly appointed third-class English railroad car to that in an ordinary American coach with its toilet rooms, and, on many roads, with reclining chairs, washing convenience, etc.

TABLE No. 52.

London and North Western Railway, of England, compared with the Pennsylvania Railroad Division of the Pennsylvania Railroad, of the United States.

	London and North Western.		Pennsylvania Railroad Division.	
	1884.	1885.	1884.	1885.
Total length of line operated, miles	1 811	1 828	1 471	1 518
Single track, miles	391	389	1 062	1 109
Double " "	1 266	1 280	302	303
Three " "	28	29	76	77
Four " "	126	130	31	32
Percentage of single track to total length of line operated	22	22	72	73
Aggregate daily trains over entire line	68	66	45	46
Average annual train mileage per mile of line operated	21 086	20 908	14 135	14 510
Average annual mileage over each mile of line operated—				
Passenger	414 361	404 079	165 310	182 256
Ton	809 153	788 725	2 095 513	2 186 078
Passenger and ton	1 223 514	1 192 804	2 260 813	2 368 334
Average annual mileage over each mile of single track, all being reduced to single track—				
Passenger	213 730	207 721	120 564	133 396
Ton	417 367	405 440	1 527 502	1 600 032
Passenger and ton	631 097	613 161	1 648 066	1 733 428
Average load of freight trains, tons	78	78	205	210
Average load of passenger trains, passengers	38	37	42	45
Average load of all trains, tons and passengers	58	58	160	167

Average cost of transporting one ton, or one passenger, one mile.	Cents.		Cents.	
	1884.	1885.	1884.	1885.
Maintenance of way	.209	.205	.103	.080
Repairs and renewals of locomotives	.082	.080	.044	.037
Total cost of motive power	.271	.270	.148	.133
Total operating expenses	1.130	1.110	.530	.410

Sidings are not included in the above mileage.

This table shows that the Pennsylvania Railroad on the Pennsylvania Railroad Division does annually twice the average amount of passenger and freight traffic on each mile of road operated, and nearly *three* times the traffic over each mile of single track (all being reduced to single track) that the London and North Western does, and with this great increase of work performed, the American road shows over the English road a reduction of *two-thirds* in the total average cost of operating expenses in transporting one ton, or one passenger, one mile.

TABLE No. 53.

London and North Western Railway of England, compared to the Knoxville Branch of the Louisville and Nashville System.

	London and North Western.	Knoxville Branch.	
	1885.	1885.	1886.
Total length of line operated	1 828	171	171
Total annual freight and passenger train mileage per mile of line operated	20 908	4 022	4 285
Average load of freight trains, tons	78	126	132
Average load of passenger trains, passengers	37	31	28
Average load of all trains, tons and passengers	58	91	96
Average Cost of Transporting One Ton, or One Passenger, One Mile.	Cents.	Cents.	Cents.
Maintenance of way	.205	.243	.168
Repairs and renewals of locomotives	.080	.045	.043
Total cost of motive power	.270	.210	.193
Total operating expenses	1.110	.819	.695

By comparing the above table with Tables Nos. 47 and 51, will be seen the advance that has been made on the Knoxville Branch Railroad in cheap transportation in three years, the total cost of transporting one ton, or one passenger, one mile having been reduced in that time from 1.069 to .695 cents, or 35 per cent., while in the three last years the London and North Western have made no reduction in their cost, being in 1883, 1.11 cents, and in 1885 the same.

This speaks well for American management and rolling stock, where a road built through a rough country, at a very moderate cost, actually transports freight and passengers at sixty per cent. of the total cost that the London and North Western does, that has been built at *over eight times the outlay per mile.*

TABLE No. 54.

Comparative Average Cost of Transporting one Ton, or One Passenger, One Mile, in Maintenance of Way and Motive Power.

No reports for 1886 from the London and North Western have been received.	London and North Western. Average of Years 1883, 1884 and 1885. Cents.	Pennsylvania Railroad Division. Average of Years. 1883, 1884, 1885 and 1886. Cents.
Maintenance of way, 1883	.202	.116
" " 1884	.209	.103
" " 1885	.205	.080
" " 1886	....	.093
Average	.205	.098
Motive power, 1883	.261	.161
" 1884	.271	.148
" 1885	.270	.133
" 1886	....	.145
Average	.267	.147
Total average	.472	.245
Excess of cost	.227	

Practically the cost on the English road for maintenance of way and motive power is double what it is on the American road for the same amount of useful work performed.

TABLE No. 55.

Comparative Work of English and American Locomotives.

	London and North Western.		Pennsylvania Railroad. Pennsylvania Railroad Division.		
	1884.	1885.	1884.	1885.	1886.
Total number of locomotives	2 476	2 507	815	819	850
Average annual revenue mileage of each locomotive	15 422	15 245	25 511	26 896	27 297
Average annual passengers, or tons, transported by each locomotive one mile	894 905	869 726	4 080 734	4 389 658	5 488 952
Average annual revenue earned by each locomotive. £ = $4.85	$20 036	$19 522	$37 039	$33 782	$36 626

This table shows that on the Pennsylvania Railroad each locomotive does more than six times the work; runs annually nearly twice the mileage; and with less than one-half the charges for traffic, earns nearly twice the revenue that it does on the London and North Western Railway.

The preceding table also shows continuous increase in the work of the American locomotive; each year showing larger results than the preceding, while the work of the English locomotive remains stationary.

This great service obtained from the American locomotive has not been done to its serious injury; this is shown by

TABLE No. 56.

Comparative Cost of Repairs and Renewals of Locomotives in Transporting One Ton, or One Passenger, One Mile.

Years.	London and North Western.	Pennsylvania Railroad. Pennsylvania Railroad Division.	In favor of Pennsylvania Railroad. Pennsylvania Railroad Division.	
	Cents.	Cents.	Amount—Cents.	Per cent.
1883	.078	.047	.031	66
1884	.082	.044	.038	87
1885	.080	.037	.043	116

From this table it appears that the English locomotive costs in repairs and renewals about *double what the American does for the same amount of work performed.*

SPEED OF FREIGHT TRAINS.

Table No. 52 confirms Table No. 22 (page 47) and my previous statements, that it is not necessary to run freight trains on the English railroads at such great and expensive speed in order to clear the track of traffic.

Table No. 52 shows that for the years 1884 and 1885 the Pennsylvania Railroad Division transported nearly three times the traffic over each mile of single track, and twice the traffic over each mile of line operated that the London and North Western did in the same time.

CHEAPLY CONSTRUCTED RAILROADS.

There can be no question that the great object in railroad construction is to build a road that will answer all the requirements for the least amount of money.

In this the American system of construction is far in advance of the English. The following letter will show what has been done on a road of very moderate cost:

"PHILADELPHIA, WILMINGTON AND BALTIMORE RAILROAD COMPANY.
"OFFICE OF SUPERINTENDENT DELAWARE DIVISION.
"CLAYTON, DEL., October 30th, 1886.

"EDWARD BATES DORSEY, Esq.,
"127 East 23d Street, New York City.

"DEAR SIR:

"Yours of the 21st instant at hand.

"The newspaper reports were wrong in regard to run from Wilmington to Salisbury, October 17th, 1886.

"The actual running time over our Division, 97 miles, was 103 minutes, and from Delmar to Salisbury on the New York, Philadelphia and Norfolk Railroad, 6 miles, 5 minutes. The time consumed altogether was 1 hour and 55 minutes by hot boxes and taking water.

"Train consisted of two flats, loaded with fire engines; probable weight for each car, 35 000 pounds gross, and one passenger car loaded with firemen.

"Philadelphia, Wilmington and Baltimore engine, built at their shop, Wilmington, Del., drew the train.

"Yours truly,

"F. N. MILLS,

"*Superintendent.*"

This gives an average speed of 56.5 miles per hour.

By the last annual report of the company the total cost of this road is $21 568 per mile.

The regular express trains on this road average 36.5 miles per hour, including stoppages. This shows that very high speed can be safely obtained with the American rolling stock on railroads of very low cost, and necessarily of inferior construction when compared with the English railroads costing more than ten times as much.

If a road of such low cost is capable of this quick and safe service, and at lower rate of operating expenses, why spend more than ten times the money in building roads that practically do no better or cheaper work?

GROWTH OF RAILROAD TRAFFIC.

The following, taken from the daily *Stockholder*, of New York, shows the rapid growth of railroad traffic in the United States, and also the great and continuous reduction in freight charges from 1865 to 1885. On the Eastern group this reduction amounted to 78 per cent., and on the Western group to 68 per cent.

By referring to page 86, it will be seen that the reduction in freight charges on the roads of the United Kingdom was very small from 1855 to 1885.

"The enormous growth of the railroad business of the country during the past twenty years, together with the wonderful reduction in the charges for doing that business, can be appreciated only by a comparison of the figures. In the following table the freight business for twenty years of some of the Eastern trunk lines has been combined in one group, and that of some of the leading Western roads which center at Chicago in a second group. The first group embraces the New York Central, the Lake Shore, the Michigan Central, the Pennsylvania and its Western connection, the Pittsburgh, Fort Wayne and Chicago, the Erie, and the Boston and Albany; and in the second group are included the Illinois Central, the Chicago and Alton, the Rock Island, the Chicago, Burlington and Quincy, the Northwestern, and the St. Paul Railroads.

TABLE No. 57.

Year.	Eastern Group.		Western Group.	
	Tons moved one mile.	Charges per ton per mile.	Tons moved one mile.	Charges per ton per mile.
1865	1 654 324 000	2.90	513 421 459	3.64
1866	2 041 412 000	2.55	576 888 638	3.46
1867	2 258 220 000	2.31	768 171 050	3.17
1868	2 651 575 000	1.95	893 856 984	3.15
1869	3 159 550 000	1.71	1 054 559 835	3.03
1870	3 744 010 000	1.58	1 234 678 291	2.42
1871	4 341 127 000	1.48	1 233 058 058	2.51
1872	5 181 259 000	1.47	1 337 038 063	2.58
1873	5 782 059 000	1.47	1 719 196 690	2.19
1874	5 879 658 000	1.34	1 851 645 824	2.16
1875	5 937 240 000	1.16	1 904 937 377	1.98
1876	6 739 524 000	.98	1 994 712 255	1.88
1877	6 536 994 000	.97	2 211 021 475	1.66
1878	8 853 397 000	.81	2 822 885 886	1.48
1879	10 120 776 000	.72	3 470 822 877	1.28
1880	10 544 831 000	.84	4 544 469 655	1.27
1881	11 659 998 000	.76	4 435 202 005	1.42
1882	11 189 060 000	.66	5 041 330 034	1.36
1883	11 141 726 000	.84	5 768 173 429	1.31
1884	10 719 518 000	.74	5 940 110 011	1.25
1885	11 331 306 000	.64	6 287 346 541	1.20

"A remarkable feature of this exhibit is found in the fact that each year throughout the whole period shows a gain in the amount of business done with only two exceptions for the Western group, and a somewhat greater number for the Eastern lines. For the Western roads there was a slight reaction in 1871, and again in 1881, but in the twenty years the tonnage rose from 513 000 000 to 6 287 000 000 tons, while the average charges for hauling a ton a mile moved steadily downward with only slight interruptions from 3.64 cents per ton per mile to 1.20 cents for like service. The business of the Eastern roads rose year by year from 1 654 000 000 tons in 1865 to 6 739 000 000 tons in 1876; there was a moderate reaction in 1877, and then the traffic continued to grow until 1882. The tonnage of 1881 was the largest in the history of the roads composing the group, unless it was exceeded by the traffic of last year, the returns for which are not complete. The average charges for doing the enormous business reported fell from 2.9 cents per ton per mile in 1865 to 0.64 cents in 1885. There is a wide difference in the charges between the Western and Eastern roads, due chiefly to the more sparsely settled condition of the West, resulting in a smaller amount of business done per mile of road, but there is the same tendency in both sections of the country—an increase in the amount of business and a decrease in the charges."

Load of Trains and Reduction of Cost.

In proof of my repeated assertions of the reduction in cost of transportation by increasing the load of trains, the following extract is taken from the last annual report of S. M. Felton, Jr., First Vice-President of the New York, Lake Erie and Western Railroad Company.

"During the year the expenses have been largely increased, as detailed above, in replacing the depreciation of former years; the result has made an increase in the cost per freight-train mile from $1.20 to $1.25, or 4.17 per cent., but this was more than equalized by an increase in the train load from 252 to 279 tons, or 10.71 per cent., resulting in a direct reduction in the cost per ton per mile from .475 to .448 cents, or 5.68 per cent. This cost is now lower than the average of the trunk lines. As an illustration of what has been done in this direction, it should be noted that the cost this year is 33.58 per cent. less than in 1878 and 15.79 per cent. less than in 1883. The most prominent factors in these results are the consolidation engine and a constant effort to load cars, as far as practicable, in both directions, and haul full trains up to the capacity of the locomotive."

Increase of Business and Reduction of Charges.

This is made very plain by the following graphical illustrations and remarks by Mr. M. R. Jefferds, an American engineer who has resided a long time in England. He also compares graphically the American, English and German average freight charges per ton per mile.

"I am prejudiced in favor of the American system for the following reasons:

"*First.*—The United States has 126 000 miles of railway to the United Kingdom's 18 900 miles, and therefore a greater daily experience.

"*Second.*—Strong competition has caused low rates for transportation, which has forced the ingenuity of railway men in America to their utmost to devise means of discounting their competitors until rates and operating expenses have been reduced to a minimum.

"*Third.*—The reduction of dead weight as compared with paying load. It has certainly been demonstrated beyond successful contradiction that by the American system the cost of carrying one ton one mile has been attended with more satisfactory results than has ever been attained in any other part of the world.

"The railway companies of England give no returns whereby I can give you such complete and satisfactory data as are given in the tables of the New York and Pennsylvania roads, but from the reports of the several English companies that I have examined, and from the deductions made by Mr. Edward Bates Dorsey, C. E., after a thorough investigation of the subject I am convinced that the average freight charge on all freight moved in the United Kingdom is 1¼d. per ton per mile, or 277 per cent. higher than the average charge made by the New York Central and Hudson River Railroad Company.

"In his paper, recently read before the American Society of Civil Engineers, Mr. Edward Bates Dorsey, C. E., said: 'It would certainly pay the management of the English railway companies to investigate the cause of the extra cost of motive power on their roads, and, if possible, remedy it. If this can be done, they will be able to decrease their operating expenses over eight per cent., without making any changes whatever in present prices. This will enable most companies to increase their dividends largely—probably over four per cent. For what is done in the United States ought to be done in the United Kingdom.' It is often asserted that the superiority of the English railway system is proved by the fact that the ratio of expenses to receipts in

England is less than fifty per cent., while in America it is 58 per cent.; but it must be remembered that in America labor and materials are high-priced and the tariff of charges low, so that the ratio of expenses must be higher than in England, where labor and materials are low and the tariff of charges high.

"Let me show you some facts and figures. I will give the decrease in charges and increase in tonnage of two of the great lines in America during a period of eighteen years. Both of these lines have been of the greatest service to the community, and very profitable to their owners. The traffic of the New York Central road consists mainly of products of agriculture and general merchandise, and the Pennsylvania the same, with the addition of minerals and coals. I will describe the figures by graphic lines, that they may be more easily comprehended.

TABLE No. 58.

New York Central and Hudson River Railroad.—Average on all Classes of Merchandise.

Year.	Total.			Ton per mile. Charge.	Measured by ratio of lines.	
	Miles.	Tons moved.	Receipts.		Decrease of charge.	Increase of tons moved.
				Pence.		
1865	804	1 167 059	$11 000 058	1.70		
1866	842	2 099 594	12 017 532	1.53		
1867	842	2 249 363	11 993 008	1.36		
1868	842	2 562 862	12 479 950	1.35		
1869	842	3 190 840	14 066 386	1.18		
1870	842	4 122 000	14 327 418	0.91		
1871	845	4 532 056	14 647 580	0.81		
1872	857	4 393 965	16 259 650	0.79		
1873	858	5 522 724	19 616 018	0.78		
1874	1 000	6 114 678	20 348 725	0.71		
1875	1 000	6 001 954	17 899 702	0.63		
1876	1 000	6 803 680	17 593 265	0.52		
1877	1 000	6 351 356	16 424 317	0.50		
1878	1 000	7 695 413	19 045 830	0.46		
1879	1 000	9 015 753	18 270 250	0.39		
1880	1 001	12 469 052	22 199 966	0.43		
1881	993	9 857 746	20 536 750	0.39		
1882	993	7 853 823	17 672 252	0.38		
1883	993	9 613 397	20 142 433	0.45		
Average charge per ton per mile by English railways				1.25		

TABLE No. 59.

Pennsylvania Railroad, Pennsylvania Division.—Average on all Classes of Merchandise.

Year.	Total.			Ton per mile. Charge.	Measured by ratio of lines.	
	Miles.	Tons moved.	Receipts.		Decrease of charge.	Increase of tons moved.
				Pence.		
1865	737	2 655 706	$11 193 565	1.32		
1866	737	3 186 359	11 709 294	1.13		
1867	737	3 709 224	11 832 300	1.03		
1868	737	4 427 884	12 882 165	0.94		
1869	737	4 991 995	12 932 657	0.85		
1870	737	5 427 401	12 793 160	0.77		
1871	737	6 575 843	14 052 305	0.69		
1872	784	7 844 778	16 856 891	0.70		
1873	869	9 211 234	19 608 555	0.70		
1874	877	8 626 946	17 227 505	0.62		
1875	905	9 115 368	15 651 741	0.52		
1876	963	9 922 911	14 539 784	0.44		
1877	1 055	9 738 295	14 642 109	0.48		
1878	1 055	10 946 752	15 904 501	0.45		
1879	1 092	13 684 041	17 016 989	0.39		
1880	1 120	15 364 788	20 234 046	0.43		
1881	1 173	18 229 365	22 400 120	0.39		
1882	1 264	20 360 399	23 517 178	0.40		
1883	1 314	21 674 160	24 536 789	0.40		
Average charge per ton per mile by English railways				1.25		

"The difference in charges made by English railways, as compared with Continental rates, has been very clearly set forth by Sir B. Samuelson, M.P., in his report to the Association of the Chamber of Commerce. He shows some startling comparisons, a few of which I will give you graphically.

TABLE No. 60.

Showing Freight Charges per Ton per Mile in England, Germany, and the United States.

Description of freight.	From	To	Length of haul lines.	Charge.	Measured by ratio of lines.
				Pence.	
Hardware	Birmingham	Liverpool	88	2.63	
"	According to	German tariff	88	1.36	
"	Birmingham	Plymouth	222	2.03	
"	According to	German tariff	222	1.09	
Cotton yarns	Manchester	Hull	89	2.42	
"	According to	German tariff	89	1.48	
Cotton goods	Manchester	London	188	2.29	
"	"	"	Export	1.34	
"	According to	German tariff E.	188	1.27	
U. S. Roads.*					
Gen. Mer.	Boston	Albany	113	0.55	
"	"	Maine	47	1.17	
"	"	Providence	29	1.41	
"	"	Lowell	40	1.17	
"	"	Fitchburg	77	0.55	
"	New York	Hartford	*57	0.98	

* On all these American roads the average cost of coal is three times greater and wages 50 per cent. higher than on the English roads.

"The benefits of these very great reductions in American rates have been secured by both producers and consumers without diminishing the dividends of the shareholders except during a stupid railway war. The improved methods, the lessening of dead weight, and consequent reduction of expenses, have been the protection of these roads. English roads have all these improvements to make, and if they are made judiciously, rates can be reduced fully fifty per cent., and shareholders will receive larger dividends than at present."

The following correspondence explains itself, and it also explains some portions of my papers.

"LONDON, October 24th, 1886.

"DEAR MR. DORSEY:

"I am sending you by to-day's book post a chapter of a book that I have in hand on Railway Problems, wherein I deal with the papers you have read on English and American Railroads Compared.

"I shall be glad to have any criticisms you may be good enough to offer thereon.

"Thanks for sending me copies of your papers.

"Yours faithfully,

"J. S. JEANS.

"E. BATES DORSEY, Esq."

"127 EAST 23D STREET,
"NEW YORK, November 12th, 1886.

"J. S. JEANS, Esq., London,

"DEAR SIR:

"Your esteemed favor of 24th ult. was received on the 1st inst., but the proof of your book was only received by the last mail, 9th inst., hence my delay in answering it. As you request I give you my views.

"I do not think it fair to compare the cost of train miles in England and United States, owing to the great difference in the train loads in the two countries both in passenger and tons; for comparison let us select the leading road of each country, as follows:

1884.	Pennsylvania Division of Pennsylvania Railroad.	London and North Western Railway.
Average train load in passengers................	42	38
" " tons..........	205	78
" " passengers and tons......	160	58

"By consulting Table No. 45 of my paper you will find that the American train load is invariably much heavier than the English. With such great difference in the train load, the comparison of the cost of train mile is misleading.

"It may be said that the ton and passenger mileage are not reported by the English railroads. This is unfortunately too true. The plan I followed to get these is described on page 16 of my paper, and is sufficiently correct for comparison. The average passenger rate is comparatively easily obtained; the average ton rate per mile is more difficult. It is certainly not less than 1d. per ton per mile, the price I assumed to be the average in the United Kingdom. This rate is more than sustained by you in your Annual Statistical Report to the British Iron Trade Association for 1884. On page 181 you say:

"'The average rates quoted for the transport of iron ore and coal in England could be varied either upward or downward according to the distance or load. But if the average rate is taken at 1d. per ton per mile, which is probably as near the mark as we can set, instead of 1.02d. as shown in the average of iron ore.'

"If the average freight charge per ton per mile on iron ore is 1.02d., and on iron and coal 1d., my estimate of 1d. average for all freight is much too low. If it is too low, then my assumed train loads (on English railroads) are too large and should be reduced.

"Railroad men here agree with me that the English railroads run too many lightly-loaded trains for economy in operating expenses. With their easy grades, easy curves and good superstructure, your trains should carry much heavier loads than ours, while in reality their loads are much lighter, in some instances being only one-third. We have found by experience the cost of transporting freight to decrease as the train load increased. See Table No. 41 in my paper.

"Your passenger trains are undoubtedly run also too lightly loaded, much lighter than ours. They should be much heavier, as your population is so much more dense. Your frequent omnibus trains are very convenient to the public, but they are run at a great cost to the railroads. Would not the public be better satisfied with fewer trains, provided there was a corresponding reduction in the fares, which are very high for the accommodation given, especially the third-class? By reducing the number of trains largely, the railroads probably could afford to make a large reduction in the fares.

"In repairs and renewals the English locomotive does not work as economically as the American. This is shown in the numerous comparisons made in Table No. 45 of my paper. In every instance, except two, the cost in moving one ton, or one passenger, one mile is higher. It would pay the English railroads to examine into this.

"Table No. 45 also shows that maintenance of way costs less on the American than on the English railroads for one ton, or one passenger, moved one mile; this notwithstanding our roads cost much less, and many are probably of inferior construction. This I cannot account for, unless it is owing to the rigid English rolling stock running with more friction and wear and tear than the pliable American bogie-truck.

"In my paper the data were collected and the comparisons made impartially. The results in many instances were a great surprise to me, being entirely unexpected.

"It would be to the interest of railroads if the points brought out in Table No. 45 of my paper should be freely discussed in both countries; and the best plan and plant adopted, without regard to its nationality.

"I hope you will use your influence with the English railroads, and induce them to report the ton and passenger mileage, and to separate in their published reports the cost of passenger and freight traffic. With these the comparisons between the railroads of the two countries could be made on exact data.

"Yours most truly,

"Edward Bates Dorsey,

"*M. Am. Soc. C. E.*"

Since the preceding letters were written, Mr. Jeans has published "Railway Problems." This is a very valuable addition to railroad literature, and is worthy of the high standing of the author, as one of the most prominent of England's statisticians.

In preparing my papers, where there was no official data, I formed my estimates from the best available data. It is very gratifying to me to see that they are fully confirmed by Mr. Jeans. For example, I estimated the maximum average cost of land per mile for railroad purposes at $20 000. Mr. Jeans, on page 34 of "Railroad Problems," estimates it at £4 000 = $19 400.

The following quotations show that he more than confirms my estimate of the average freight charge per ton per mile, which proves that my estimate of the ton mileage is too conservative. These quotations also confirm my statement that the American railroad is constructed and operated much more economically than the English.

On page 55 he compares the English and American railroad system as follows:

"Since 1871 the working expenses of the system (American) as a whole have only increased from £68 750 000 sterling to £72 866 000 sterling, being an increase of only £4 116 000, or about 5.9 per cent., while the net receipts have increased by £72 276 000, or about 468 per cent. Concurrently with this movement the gross receipts have increased from £84 000 000 to £160 500 000, being an advance of about seventy-six millions, or 90 per cent. These figures, and the enormous increase of capital expenditure in the same interval (from £555 250 000 to £1 599 250 000), explain the remarkable fact that while the gross earning power of capital has fallen from 15 to 10 per cent., the net earning power of the same capital has advanced from 2.8 to 5.4 per cent, concurrently with a general reduction of freight rates that is computed at a total of not less than £100 000 000 sterling a year, or £12 000 000 more than the total net receipts for 1884. In the United Kingdom the course of railway finance has been very different, the total traffic receipts having increased from £51 250 000 to £71 000 000, the net receipts from £25 750 000 to £31 750 000, and the working expenses from £25 750 000 to about thirty-six millions sterling. In other words, to earn an additional £72 250 000 of net receipts, the working expenses of American lines have been increased by a little over four million sterling; but in the United Kingdom there has been an increase of over ten millions in working expenditure to earn about six millions more of net receipts.

"But this is not the only remarkable feature of the comparison; or, to speak more correctly, of the contrast. The railways of the United States have effected this increase of 468 per cent. in their net receipts concurrently with an enormous reduction in rates and fares, whereas in the United Kingdom any reductions that have occurred in these directions during the same interval have been immaterial. This is substantially proved by the fact that in the United Kingdom the average rate per ton carried and the average fare per passenger have scarcely varied as between the one period and the other."

This is a very strong indorsement of my statements and also of American railroad management.

Mr. Jeans quotes very largely from the United States census reports of 1880. This is very unfair to the American railroads, as very great progress has been made since then in the economy of operating expenses. He also takes the average cost of operating all American rail-

roads. This is also very unfair, unless the cost of construction is considered and credits be given for interest saved. It is safe to say that one-half of the total American railroad mileage did not cost over one-eighth of the average cost of the English railroads per mile, hence it is very unfair to compare the cost of operating expenses on the same basis. Also allowance should be made for the higher wages paid in the United States.

On pages 251, 285, 320 and 361 he confirms my estimated average freight charge as follows:

Regarding rates, on page 285 he says:

"English railways practically work upon the same tariffs to-day as they did in the infancy of the system."

On page 320 he says:

"It is probable that the average ton-mile rate on English railways will not be much, if any, under 1¼d., which is just three times the amount charged on the principal American lines."

On page 361 he says:

"We have no direct clew to the average ton-mile rate on English railways, but if we assume that it is only 1d., we should arrive at an average of rather under 70 tons per train mile; and inasmuch as the average ton mile rate is generally believed to be nearer 2d. than 1d., the average live load of a goods train is likely to be nearer 50 than 70 tons."

From the preceding it is evident that my estimated freight rate per ton mile is too small, consequently my estimated freight train load is too large. This will make the comparative cost of transportation still more unfavorable to the English railroads.

Direction of Freight.

It has been stated by some of the chief officers of English railroads that one of the principal reasons for the difference of cost of freight on English and American railroads is that the English freight is largely in one direction, necessitating hauling empty cars back.

The English reports give no data on this point.

The report of the Pennsylvania Railroad for 1886 gives the following for all their divisions, viz.

Mileage of east bound freight per cent. of total freight mileage,	74.5
Mileage of west bound freight per cent. of total freight mileage,	25.5

In other words, for every loaded car sent west, three empty ones were also sent.

It is very doubtful if any of the English roads can show such great disproportion in the direction of movement of freight traffic.

CONCLUSIONS.

The preceding results have been obtained by careful comparisons of data derived from official reports or from returns of the Board of Trade of Great Britain, and not by comparing isolated or selected railroads for short periods. But, on the contrary, the workings for the last four years of all the principal railroads of the United Kingdom have been compared with some of the smallest and also with some of the most extensive of the United States for the same period.

A careful perusal of the preceding pages must convince the most skeptical that American railroad management is much more economical than English, and that the American locomotive will do the same amount of work as the English at about one-half the cost for "Repairs and Renewals" and "Total Cost of Motive Power."

After four years careful study of the English railways, I have no doubt that by adopting the American system of management and American rolling stock, they could afford to largely reduce their freight and passenger charges; or, by keeping the charges as they are now, the stockholders would have the pleasure of receiving *very much larger dividends.*

EXTRACTS FROM THE PRESS.

ENGLISH AND AMERICAN LOCOMOTIVES COMPARED.

An extremely interesting comparison of the workings of English and American locomotives has been thoroughly made for the first time in a series of papers, full of official data, read recently before the American Society of Civil Engineers by Edward Bates Dorsey, a Member of that Society, who has apparently studied the question very closely both here and in England. These papers, which include forty-nine tables, some very large and elaborate, contain a great deal of official matter and some that has never been published before, and it has been analyzed and compared very impartially. Comparisons are made of the costs on representative English and American roads of transporting one ton, or one passenger, one mile, distributed under the heads of maintenance of way, repairs and renewals of locomotives, total cost of motive power, etc. To those who are familiar with American railway reports the explanation must be made that the English do not separate the passenger and freight traffic, hence they cannot be separated in these comparisons.

We will select two of the many comparisons made in Mr. Dorsey's papers, who takes for his examples the London and North Western and Pennsylvania Railroad, each being assumed to be among the best and most extensive of its representative type.

COST OF TRANSPORTING ONE TON, OR ONE PASSENGER, ONE MILE.

1884.	London and North Western.	Pennsylvania Railroad Division.
Maintenance of way	$0.00209	$0.00103
Repairs and renewals of locomotives	.00082	.00044
Total cost of motive power	.00271	.00148
Total	$0.00562	$0.00295

Each one of these items is about double on the English what it is on the American road; yet the American has one summit of 2 154 feet elevation above the sea. This great difference of cost must be owing mostly to the different types of rolling stock used. Of these the locomotive is the most important. The stiff and long rigid wheel base of the English locomotive undoubtedly runs with more friction, and the wear and tear on itself and on the rails and permanent way must be much greater than with the comparatively articulated American locomotive. This is more fully shown under the head of "Repairs and Renewals of Locomotives" —for the same work the average cost of the American being one-half of the English.

Our cheaply constructed roads compared with first-class English roads show similar economy, but of course not so great. Substituting for the Pennsylvania Railroad in the preceding table the Knoxville Branch of the Louisville and Nashville system, we have:

1884.	London and North Western.	Knoxville Branch.
Maintenance of way	$0.00209	$0.00404
Repairs and renewals of locomotives	.00082	.00052
Total cost of motive power	.00271	.00239
Total operating expenses	.01130	.01069

This is a remarkable showing for the American road, as its cost of construction per mile was only $26 464, about one-tenth of the average cost of English roads, and yet it is operated at less cost. This also shows the superiority of the American locomotive, as owing to its low cost the road must undoubtedly be rough and hard on rolling stock, yet the average cost of "repairs and renewals of locmotives" and "total cost of motive power" are much less than on the English roads. It would be very interesting to compare the different items composing operating expenses of the Louisville and Knoxville branch with those of an English road operated with English locomotives and other rolling stock and of the same average cost—$26 464 per mile—running through a similar rough country, if such road so operated could be found.

It also appears that the American locomotive has greater endurance than the English. Each locomotive averaged, in the year 1884, on the Pennsylvania Railroad 25 511 revenue miles, against 15 422 on the London and North Western. The annual average revenue in 1884 earned by each locomotive on these roads was $20 506 (£4 228) and $40 273 re-

spectively, the earnings of the American engine being double of the English, notwithstanding the average freight charges on the American are less than half those on the English road.

In short these papers show that the American locomotive runs two-thirds more miles and earns double the amount of money annually, while the cost for work actually done is one-half in maintenance of way, repairs and renewals of locomotives and motive power.—*The Railway Age.*

MEETING OF THE AMERICAN SOCIETY OF ENGINEERS.

DENVER, COLO., July 5th.

At a meeting of the American Society of Civil Engineers, held in this city to-day, an important paper was read by Edward Bates Dorsey, M. Am. Soc. C. E., on the subject of "English and American Railroads Compared," in which, after giving exhaustive data from official reports, he gave the comparative cost of transporting one ton of freight, or one passenger, one mile in maintenance of way and motive power, as follows:

	London and North Western. Average of years 1883 and 1884.	Pennsylvania Railroad Division. Average of years 1883, 1884 and 1885.
	Cent.	Cent.
Maintenance of way	0.206	0.100
Motive power	0.266	0 147
Total	0.472	0.247
	0.247	
Excess of cost on London and North Western	0.225	

No reports for 1885 from the London and North Western have been received.

He showed that this excess is more than half of the total cost of all operating expenses of the Pennsylvania Railroad in 1885. "It cannot be said that the Pennsylvania Railroad has favored to any serious extent these two accounts at the expense of others, as total cost of all operating expenses in 1885 was less than the aggregate of these two items on the London and North Western." If this amount could be saved, it would, on the traffic of the London and North Western Railway, amount to an annual saving of about one million pounds sterling. Mr. Dorsey says: "This estimate is based upon the prices actually paid. This saving would be still more largely increased if proper allowance were made for the difference in the price of labor and materials used on the two railroads." The paper was concluded with the last sentence of Mr. Dorsey's first paper upon this subject, which was as follows: "For what is done in the United States ought to be done in the United Kingdom."—*Financial News, London.*

AMERICAN AND ENGLISH RAILROADS.

The *Mechanical World*, of Manchester, England, that some time since took exceptions to our statement that there are not in all England 439 miles of road in as good line and surface as are found on the Pennsylvania road between Jersey City and Pittsburg, has accepted our invita-

tion to carefully read Mr. Dorsey's paper, showing the superior economy of our practice in spite of the fact that our wages are almost double theirs on an average. And though it judiciously abstains from any entanglement with Table No. 45, to which its attention was particularly solicited, both our article and Mr. Dorsey's paper are discussed with an evident desire to afford each fair treatment.

Our contemporary reiterates its view that English tracks are in better order than ours. But it is doubtful if any certainty can be arrived at as to which is right without sending over a Dudley dynograph car, such as has been used in this country, with its record. The cost of maintenance of way per passenger or ton mile is given by Mr. Dorsey as .206 of a cent on the London and North Western and .1 of a cent on the Pennsylvania, and the cost of motive power on the two roads as .266 and 0.174 of a cent respectively, making the excess of cost of the combined maintenance of way and motive power, .225 of a cent for the London and North Western. It is submitted that if the track of the Pennsylvania road is not better than that of the London and North Western, there must be something miraculous about the Pennsylvania's rolling stock.

It is, however, freely admitted that we have some roads which are much rougher than any in England, possibly than any others in the world. In spite of this, and the fact that our trains average twice as much paying tonnage as the English, there is no doubt that our locomotives make on an average about twenty-four per cent. greater annual mileage than the English on roads of easier grades and curves, that in general are better surfaced than ours, and Mr. Dorsey's paper shows that the cost of locomotive repairs and renewals per train mile is, on the average, in favor of the American locomotive. It will be remembered that although many of Mr. Dorsey's tables and deductions have been published in *Engineering*, and either printed or referred to in all American engineering journals, their accuracy has never yet been questioned in any known publication.

Under these circumstances, it does not seem to us that the *Mechanical World* is working in the direction of progress when, after advising the use of steel in locomotive construction as a possible element of economy, it says:

"Assuming this to be done, however, there is not much further saving to be made. On the level and straight lines of this country it is questionable if the extra cost of bogie trucks to locomotives is worth incurring, but we believe a great saving might be made by a better construction of vehicle."

We have already urged that a machine which is good on a rough track will not pound itself to pieces on a good one, in spite of Sir Charles Douglas Fox's opinion to the contrary. And though in certain states of the American locomotive market, engines are doubtless higher priced here than in England, as in the case cited by our contemporary, on the average the American locomotive, as shown by the statistics of both countries, and by the foreign and "colonial" demand, is the superior instrument of transportation as well as the cheapest. This is shown by the fact that all the roads in Canada, though built with British capital, are now equipped with American locomotives, or English locomotives that have been altered to conform to the American type. And we think ourselves justified in restating our opinion that the London and North Western could save money by throwing away its 2 476 locomotives and purchasing 550 of an *efficiency* equal to that of the average American

engine, notwithstanding our contemporary's objections to the use of the word efficiency.

The point that it would be difficult for 550 locomotives "to head at one and the same time, say 1 200 trains" involves a question as to the necessity for 1 200 trains at one and the same time. We think that number no more necessary or even expedient than the costly copper fire-boxes and brass tubes used in English locomotives, or the phenomenally high freight rates paid by British manufacturers to men who are, to use the words of our contemporary, "throttling commercial enterprise." Mr. Dorsey gives the aggregate daily trains over the entire line of London and North Western (1 181 miles) as 68, and over the Pennsylvania (1 471 miles) as 45, and the average load of all trains in tons or passengers as, for the London and North Western, 58; Pennsylvania, 160; and the products of these figures are 3 944 and 7 200 respectively.

There can be no necessity for the small freight trains one everywhere sees in England, and the American practice of large trains should be at once adopted. A *convenience*, accompanied by slightly increased traffic, doubtless accrues from frequent passenger trains, but the investigations of Mr. Wright, when Labor Commissioner of Massachusetts, show that the average wages in England are only 60 per cent. of those paid in this country, and there is a still greater difference between the compensations of those who receive "salaries," excepting only the few heads of departments. The profits of manufacturing are probably greater there than here, but the few of these two classes can form but a fraction of a percentage of those who travel, and there is no corresponding advantage to offset the expense of frequent trains to save time that is earning so little money, when we are satisfied with less frequent service.—*Engineering News.*

English and American Railroads Compared.

The London *Ironmonger* of August 7th (1886) has taken up the gauntlet in defense of the English railroads, in answer to our remarks on Mr. Edward Bates Dorsey's paper (*Engineering and Mining Journal,* July 17th). It is noteworthy that no other English technical paper and no English engineer has yet attempted to disprove Mr. Dorsey's figures, or has brought out any other official statistics that would invalidate his conclusions. On the contrary, the highest of English authorities, *Engineering,* in its issue of August 20th, virtually confirms Mr. Dorsey's statement, and, perhaps unintentionally, answers the *Ironmonger's* criticism in many points.

Mr. Dorsey's figures were all taken from the companies' official reports, or from the Board of Trade returns, so that, unless the accuracy of these be disputed, we cannot see how his conclusions can be questioned.

It is perhaps natural that the *Ironmonger* should feel mortified to find that English roads not only cost more to build and to operate, and that their locomotives are far less durable and efficient than American, but that the whole cost of transporting freight and passengers, even with cheaper coal and lower wages, is nearly double as much as in England as in this country. This is certainly a fact sufficiently startling to attract attention and to bring out a contradiction if it were not indisputable. Mr. Dorsey's statements are specific, and since no one has yet been found to bring forward any facts to controvert them, we must conclude that they are incontrovertible.

Our contemporary should certainly afford space to Mr. Dorsey's full

and extremely valuable table, and not quote only a few selected figures from it. Its readers would then wonder, as we do, where it found foundation for the assertion that "in respect of the cost of maintaining the permanent way, all the comparisons are immensely in favor of Great Britain."

Will the *Ironmonger* please publish the following table from Mr. Dorsey's paper?

COMPARATIVE COST OF TRANSPORTING ONE TON, OR ONE PASSENGER, ONE MILE IN MAINTENANCE OF WAY AND MOTIVE POWER.

No reports for 1885 from the London and North Western have been received.	London and North Western. Average of years 1883 and 1884.	Pennsylvania Railroad Division. Average of years 1883, 1884 and 1885.
	Cent.	Cent.
Maintenance of way....	.206	.100
Motive power................................	.266	.147
Total................................	472	.247

"This excess of .225 cent is more than half of the total cost of all operating expenses of the Pennsylvania Railroad in 1885.

"It cannot be said that the Pennsylvania Railroad has favored to any serious extent these two accounts at the expense of others, as the total cost of all operating expenses in 1885 was less than the aggregate of these two items on the London and North Western.

"If this amount could be saved, it would, on the traffic of the London and North Western Railway, amount to an annual saving of about five million dollars. This estimate is based upon the prices actually paid. This saving would be still more largely increased if proper allowances were made for the difference in the price of labor and material used on the two railroads.

"What is done in the United States, *ought* to be done in the United Kingdom."

The *Ironmonger* seeks consolation in the fact that the cost is less per train mile on the English roads where the trains carry only from one-half to one-fourth as much as American trains. As the very *raison d'être* of a railroad is to transport freight and passengers, and not to run empty cars, we in this country are inclined to consider the economy with which the freight or passenger is moved, rather than the train-mile cost, as the measure of the efficiency of the road. It will not be questioned that a small empty train can be moved cheaper than a large loaded one, any more than that a steam yacht will cost less to run per mile than a loaded Cunarder. Mr. Dorsey's paper also gives a table on page 15, stating the speeds of some of the fastest trains in the United Kingdom and in this country, and our contemporary will there find that the fastest train time between terminal stations is on an American road. Even in this country of great distances we do not find it advantageous to run freight trains as fast as is done on the English roads, and since an average speed of twenty miles an hour would cross England in almost any direction during a night, we can still less understand the necessity for great speed there.

Try again, worthy contemporary. This defense is not much better than that of the "eminent authority" that gravely assured us that

American locomotives may be durable on rough American roads, but they shake themselves to pieces when they get on good English-built roads.—*Engineering and Mining Journal.*

ENGLISH *vs.* AMERICAN LOCOMOTIVES.

Considerable interest has been attracted to the exhibit by Mr. E. B. Dorsey, made before the American Society of Civil Engineers, of the superior economy of American locomotives as compared with those made and in use in the United Kingdom. In a supplementary paper "read last week" at the Denver meeting of the Society, says the *Engineering and Mining Journal,* July 17th (1886): "Mr. Dorsey showed very conclusively that the cost of transporting one passenger or one ton per mile has remained practically the same on all roads in Great Britain during the past thirty years, while on all New York roads it has been decreased 51 per cent., and on the Pennsylvania Railroad 76 per cent., from 1855 to 1884. Comparing the London and North Western, the greatest of the English roads, with the Pennsylvania road, it is seen that the cost of transporting one ton, or one passenger, one mile on the English road is about double what it is in this country. If the English locomotives could be made to work as economically as American engines on the Pennsylvania Railroad, the saving in repairs and renewals of locomotives alone on the London and North Western road with its 2 476 engines would amount to $840 000 a year. But the English locomotives on this road make less than two-thirds of the mileage, and haul only 36 per cent. as much load as do the engines on the Pennsylvania road. It appears therefore that 550 American locomotives on the Pennsylvania Railroad actually do the same amount of work as 2 476 engines on the London and North Western Railway. These 550 locomotives would cost, say $5 500 000, which the company could borrow at 4 per cent., or for $220 000 a year, while its saving in repairs and renewals would amount, as shown above, to $884 000 annually. If, therefore, the work actually done on these roads be taken as a measure of the relative value of the two classes of locomotives, it is evident the London and North Western Company could make a clear annual saving of $620 000 by giving away or dumping into the sea its 2 476 English engines and substituting for them 550 American locomotives, and working them as they are worked on the Pennsylvania Railroad."

Mr. Dorsey's figures are stated to have been compiled from official records and reports.—*Bradstreets.*

The very high freight rates on English roads turn the attention of the public to the cheaper transportation thought possible by canals, as necessary to the retention of their manufacturing and commercial position. The London *Times*, in an article on the subject, says: "The cost of internal carriage, though not producing any excessive remuneration to shareholders, presses with stifling weight upon industry. Our application of science and capital has yielded the grotesque result that foreigners at a great distance can beat our own producers out of the home market, merely because they send their goods by sea, while the home producer has to send his by rail. * * * The fact remains that this country, with high rates of internal transport, is at a great disadvantage in competing with other countries where the rates are low. The regulation of railway rates may do something to remove grievous anomalies, but the only real remedy for the general costliness of a service carried out with very expensive apparatus is to develop and extend the

less expensive modes of communication which railways have thrown into the background."

In the absence of any returns, by English roads, of the cost or the amount by ton miles of their traffic, it is impossible to state the expensiveness of this internal traffic, which presses with stifling weight upon industry. Mr. Jeans, in his "Railway Problems," page 320, puts it at $1\frac{1}{4}$d., which is just three times the amount charged on the principal American lines, as already ascertained, and on page 251, $1\frac{1}{4}$ to $1\frac{3}{4}$d. *Engineering* thinks it certainly more than 1d., and Mr. Dorsey, in his papers read before the American Society of Civil Engineers, "English and American Railroads Compared," assumes 2 cents as a minimum. Mr. Jeans, "Railway Problems," page 56, says, in comparing the roads of the two countries as investments: "The railways of the United States have effected this increase of 468 per cent. in their net receipts concurrently with an enormous reduction in rates and fares, whereas in the United Kingdom any reductions that have occurred in these directions during the same interval (since 1871) have been immaterial. This is substantially proved by the fact that in the United Kingdom the average rate per ton carried and the average fare per passenger have scarcely varied between one period and the other."

Messrs. Colburn & Holley, in "The Permanent Way and Coal-Burning Locomotives of European Railways," thought that in 1855 and 1856 the rate was $2\frac{3}{4}$ cents, and Mr. Conder says in the Report of the Select Committee of the House of Parliament on Canals, 1883, that the rate is 1.08d., adding: "Fifty years after the opening of the Liverpool and Manchester Railway, it costs more to convey a bale of cotton from one city to the other than it did in 1829." This cost, according to Sir Bernard Samuelson's report to the President of the Association of the Chambers of Commerce of the United Kingdom, is $5\frac{6}{10}$ cents per ton mile.

In the United States, as returned in Poor's Manual, the figures have been as below:

Year.	Ton mileage.	Freight earnings.	Charge per ton mile, cents.
1883..............	44 064 923 445	$549 756 695	1.236
1884..............	44 725 207 677	502 869 911	1.124
1885..............	49 151 894 469	519 690 992	1.056

Our freight transportation is then, the cheapest in the world, as England's is about, if not quite, the dearest.

As it is safe to say that this country has no advantage over England in the cost of raw material of railroad construction and maintenance, and as the researches of Carroll D. Wright, when Labor Commissioner of Massachusetts, showed that the average wages here are $1.42 against $1 in England, an investigation, by persons conversant with the details of railroad management in both countries, of the causes for "the general costliness of the service carried out with very expensive apparatus," would be of great service not only to England, but to those countries which, buying both professional services and rolling stock, might hesitate before adopting the costly methods referred to by the *Times.—Railroad Gazette.*

English and American Railroads Compared.

We have several times referred to the remarkable facts demonstrated in Mr. E. B. Dorsey's paper on this subject, read before the American Society of Civil Engineers. In this elaborate statistical summary, the superior economy of American roads and locomotives is shown in a manner so authoritative that not a single English engineer or English

publication has thus far ventured to refute the fact, and we have reason to believe it has already induced the progressive head of the greatest of the English roads to secure the services of an engineer thoroughly familiar with American practice and qualified to appreciate its good points.

The subject of economy in transportation is one of such vital importance, that we gladly devote some space to the subject, and reproduce Mr. Dorsey's very valuable tabulated statement comparing the working expenses of the English and American roads.

Mr. Dorsey shows, in a supplementary paper read last week at the Denver meeting of the Society of Civil Engineers, that the cost of transporting one passenger, or one ton, per mile has remained practically the same on all roads in Great Britain during the past thirty years; while on all New York roads it has been decreased 51 per cent., and on the Pennsylvania Railroad 76 per cent., from 1855 to 1884. Comparing the London and North Western, the greatest of the English roads, with the Pennsylvania road, it is seen on the accompanying table that the cost of transporting one ton, or one passenger, one mile on the English road is about double what it is in this country.

If the English locomotives could be made to work as economically as American engines on the Pennsylvania Railroad, the saving in repairs and renewals of locomotives alone on the London and North Western road, with its 2 476 locomotives, would amount to $840 000 a year. But the English locomotives on this road make less than two-thirds of the mileage and haul only 36 per cent. as much load as do the engines on the Pennsylvania Railroad. It appears therefore that 550 American locomotives on the Pennsylvania Railroad actually do the same amount of work as 2 476 engines on the London and North Western Railroad.

These 550 locomotives would cost say $5 500 000, which the company could borrow at four per cent., or for $220 000 a year, while its saving in repairs and renewals would amount, as shown above, to $884 000 annually. If, therefore, the work actually done on these roads be taken as a measure of the relative value of the two classes of locomotives, it is evident that the London and North Western Company could make a clear annual saving of $620 000 by giving away or dumping into the sea its 2 476 English engines and substituting for them 550 American locomotives, and working them as they are worked on the Pennsylvania Railroad.

The surprising figures compiled by Mr. Dorsey from the official records and reports cannot be dismissed with a mere expression of opinion or by ignorant assumptions, or answered with anything but better records of actual work done.

In the face of these records, as well as in the light of every engineer's experience, how supremely absurd is the following statement, recently made in a discussion on "Economical Construction of Railroads," before the London Institution of Civil Engineers by Sir Douglas Fox:

"His experience had been that, as long as the line was in a bad condition and in the hands of the contractor, no praise was thought too great for the American engine; but when it came into the hands of the company, and economy became the question, it was otherwise. * * * The result was, that on a roughly-laid permanent way the American locomotive would keep on the road, while the English engine would soon find its way off. But the moment there was a good road to run upon, there was no comparison between the two engines in regard to cost of repairs."

A locomotive that will be durable and efficient on a rough road, but goes all to pieces on a good road, is a mechanical curiosity worthy of note, and no less curious than such an opinion as this from an engineer.

And the following intelligent opinion expressed in the same discussion by Mr. R. H. Burnett:

"The 'sole essential difference,' or the main difference, in the locomotives of the two countries consisted in the general inferiority in the design, details and materials, as well as in the finish of American engines. * * * American locomotives were much inferior, both in endurance and in economy in working to English-made ones. * * *

"The boasted superiority of American locomotives, either as regarded efficiency, durability, or economy in working, was without any foundation in fact."

These gentlemen may profit by studying the official reports, summarized in the accompanying table, and other figures given by Mr. Dorsey, but for which we have not space.—*Engineering and Mining Journal.*

THE DISCUSSION ON GORDON'S ECONOMICAL CONSTRUCTION OF RAILWAYS.

Although a great deal was said in the way of explaining some of the statements made in Mr. Dorsey's paper, Mr. Marcus Smith even thinking "such statements were calculated to mislead the public, and were eagerly repeated by speculators seeking concessions, contracts and subsidies for the construction and operation of railways in foreign countries," the greater portions of the remarks were directed to our rolling stock. Mr. Fforde, he of the hornet's nest, found that "when stopping for refreshments thirty or forty persons would get out (of American cars), and that occupied four or five minutes." He had also found "an intelligent engine-driver," who told him "the American engines are very good and handy, and do their work well; but when they want extensive repairs you can do nothing with them—you must get a new one." Sir Charles Douglas Fox's experience had been that as long as the line was in bad condition no praise was too great for the American engines which were made so flexible as positively to alarm Scotch and English makers. "The result was that on a roughly laid road the American locomotive would keep the track while an English one would soon find its way off. But the moment there was a good road to run upon there was no comparison between the two engines in regard to the cost of repairs." Unfortunately for this mechanical paradox, Mr. Dorsey has compared the cost of repairs on the London and North Western and on the feeder branches of the Louisville and Nashville system, as read before the American Society of Civil Engineers at their Denver meeting, and printed in ENGINEERING NEWS of July 10th, and where, on the Knoxville branch for instance, the comparison of the cost of repairs and renewals of locomotives per train mile is not, as will be observed, at all to the credit of the London and North Western.

None of the English engineers mentioned the fact that the rolling friction of American cars and engines is much less than that of the English; a fact that in part accounts for our much greater engine load, as the greater flexibility of our stock accounts both for its less cost for repairs and renewals, and our but slightly greater cost of maintenance of way. It seems evident that rolling stock which can carry passengers comfortably 40 miles per hour over an unballasted road, must be both easier on itself and on the road bed than rolling stock on which the travel would be alarming and probably very unsafe. It was probably

this consideration, as well as noticing the difference in cost of repairs, that induced the managers of the Canadian railroads to give up their English rolling stock and adopt the American type.

The relation between work done and cost of repairs on a permanent way not more roughly laid than the average English road bed, but of decidedly sharper curvature, is shown by the following table kindly contributed to the discussion of Mr. Dorsey's paper by John Henney, Jr., Superintendent of Motive Power on the New York, New Haven and Hartford Railroad, showing the mileage for the years ending at the dates mentioned of four engines on that road.

No. of engine.	End of year.	Miles run.	Cost of repairs during year.
35	January, 1886..........	76 925	$273 18
103	October, 1885..........	71 275	206 88
107	February, 1886....	68 783	281 83
122	May, 1886....	82 142	266 37
Average........................		74 781	$257 07

We have not seen any English record that equaled this, either in miles run or in low cost of repairs.—*Engineering News.*

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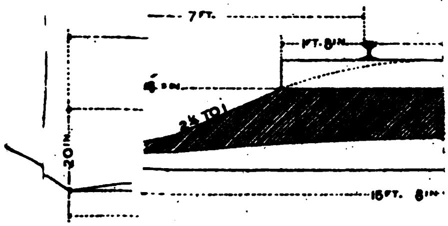
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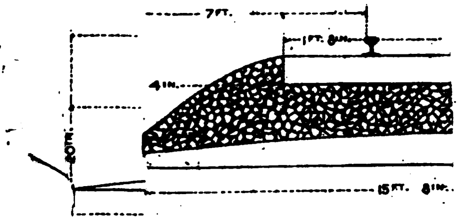
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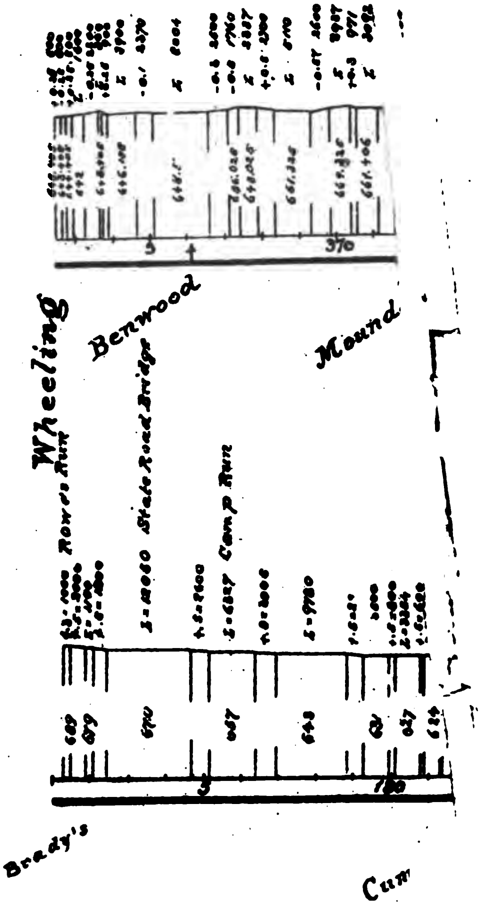
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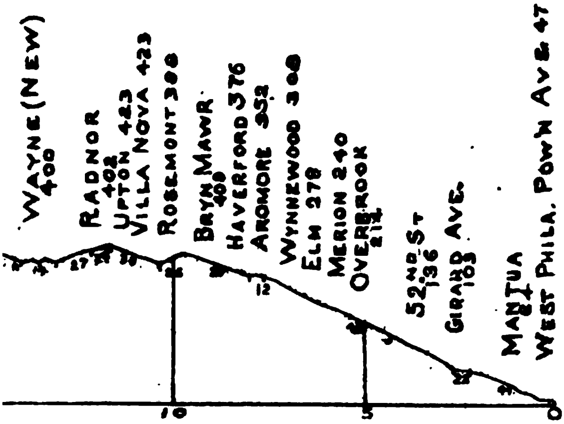

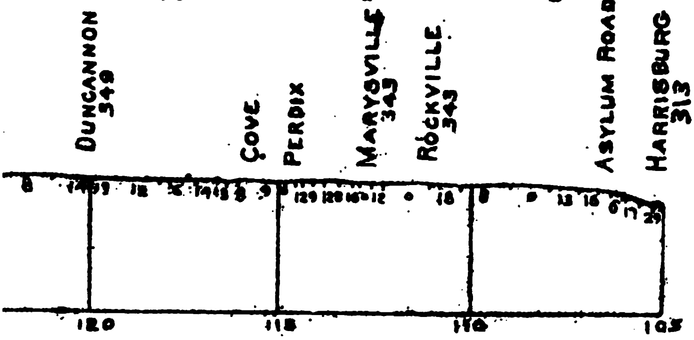

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PLATE II.
TRANS. AM. SOC. CIV. ENG'RS.
VOL XV. Nº 318.
DORSEY ON
ENGLISH AND AMERICAN RAILWAYS.

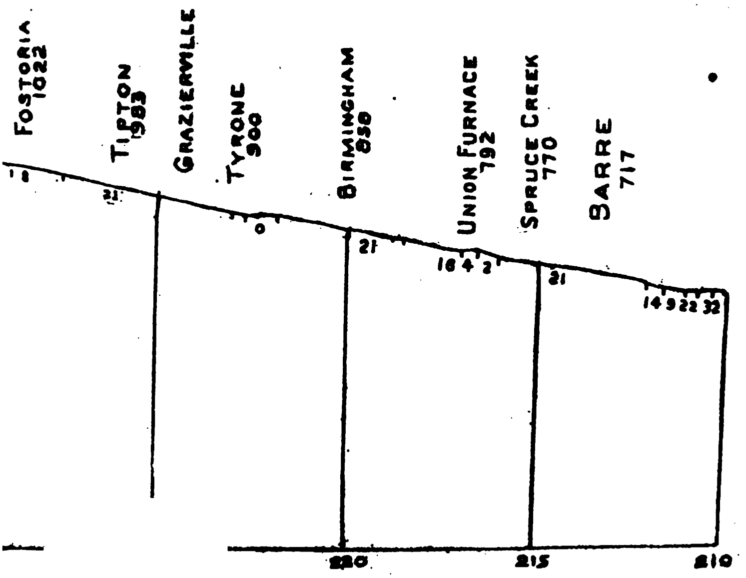

PLATE III.
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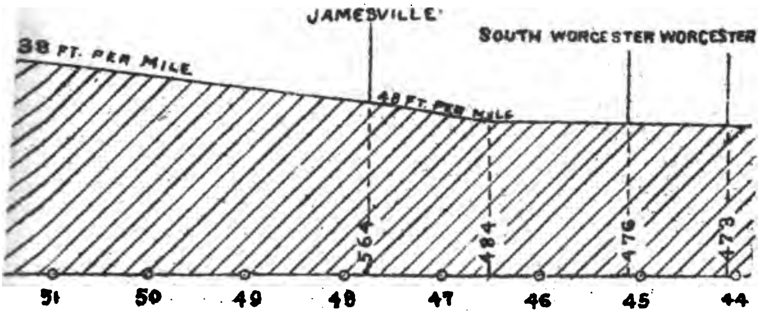
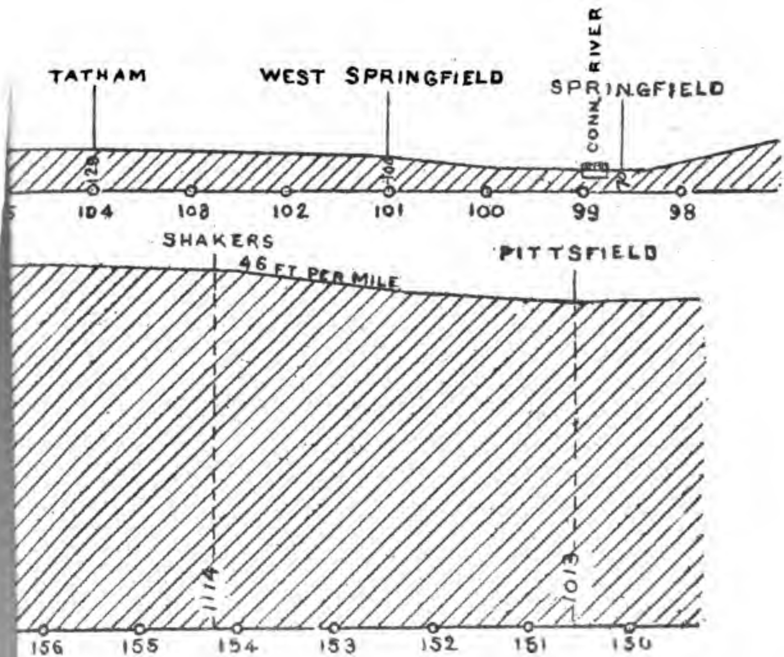
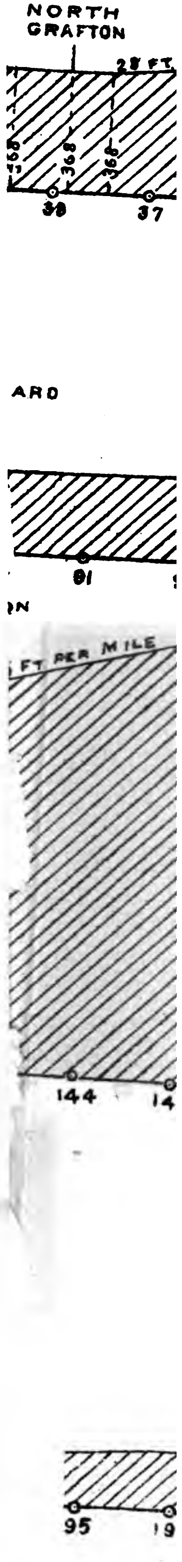
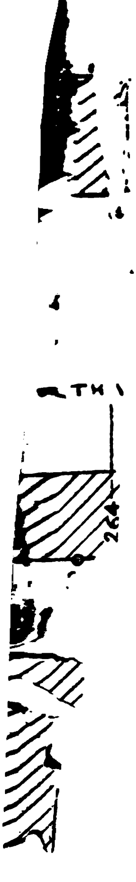
DORSEY ON
ENGLISH AND AMERICAN RAILWAYS.





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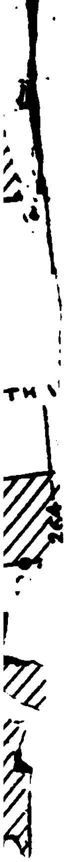

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